The Community Aquatic Monitoring Program (CAMP) for Measuring Marine Environmental Health in Coastal Waters of the southern Gulf of St. Lawrence: 2006 Overview

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by

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ABSTRACT

In 2003, the Department of Fisheries and Oceans (DFO) Gulf Region developed a monitoring program called the Community Aquatic Monitoring Program (CAMP) to help determine the ecological health of estuaries and coastal shorelines in the southern Gulf of St. Lawrence (sGSL). The primary goal of CAMP continues to provide an outreach program for DFO to interact with community environmental groups. The monitoring aspect developed from this partnership was to test the hypothesis that a relationship exists between the health of an estuary or coastal shoreline and the diversity and abundance of finfish and crustacean species which inhabit the littoral or near shore zone. CAMP expanded the number of locations from 4 in its 2003 pilot year (Thériault et al. 2006) to 24 throughout the Maritime Provinces of Nova Scotia (NS), New Brunswick (NB) and Prince Edward Island (PEI) in 2004. Baseline sites, meaning sites at which 6 stations were sampled by day-time beach seining once a month from May to September inclusive numbered 15 in 2004. In 2005, the number of locations totalled 22 of which 20 were considered as baseline (Weldon et al. 2007). In 2006, there were 22 locations participating and 18 were able to collect data for the five full months. Each community environmental group adhered to the same sampling methodology and related protocols as outlined in Weldon et al. (2005). All species of finfish, crabs and shrimp collected were identified, separated into young of the year and adults, enumerated and then released. Habitat was also characterized by collecting information such as water temperature, salinity, dissolved oxygen, % plant cover and algae cover and, once a year in September, collection of a substrate sample for measurement of grain size distribution, % moisture content and % organic content. Two water samples were collected at each location and analysed for nutrient content. This report summarizes baseline physical and biological data for the estuaries sampled in 2006. This year slightly less than four hundred thousand animals were processed and 35 different species were identified. In order to test the hypothesis that these data reflect environmental quality, several years of data will be required to detect temporal and spatial patterns that may exist. Ultimately it is hoped that this program will prove to be a simple method of characterizing estuarine health that community groups will find both useful and easy to apply.

RÉSUMÉ

En 2003, le Ministère des Pêches et Océans (MPO) de la Région du Golfe a mis au point un programme de surveillance intitulé Programme de surveillance de la communauté aquatique (PSCA) afin d'évaluer la santé écologique des estuaires et des zones du littoral du sud du golfe du Saint-Laurent (sGSL). L'objectif primaire du PSCA continu toujours d'offrir un programme d'extension permettant au MPO d'interagir avec les groupes environnementaux des collectivités. L'aspect de surveillance issu de ce partenariat vise à mettre à l'essai l'hypothèse qu'une relation existe entre la santé d'un estuaire ou d'une zone côtière et la diversité et l'abondance de poissons et de crustacés qui se trouvent dans la zone littorale ou côtière. Le PSCA est passé de 4 emplacements lors de l'année du projet pilote (Thériault et al. 2006) à 24 répartis partout dans les provinces Maritimes, soit la Nouvelle-Écosse (N.-É.), le Nouveau-Brunswick (N.-B.) et l'Île-du-Prince-Édouard (Î.-P.-É.) en 2004. Les emplacements principaux, soit les emplacements où on a effectué des prélèvements mensuels diurnes dans six stations, à l'aide de seines de plage, de mai à septembre, s'élevaient à 15 en 2004. En 2005, le nombre d'emplacements atteignait 22, dont 20 emplacements principaux. En 2006, 22 sites ont été échantillonnés dont 18 d'entres eux ont été échantillonnés de mai à septembre. Chaque groupe environnemental communautaire a utilisé la même méthode d'échantillonnage et les protocoles connexes décrits par Weldon et al. (2005). Les individus de chaque espèce de poissons, de crabes et de crevettes capturés à l'aide d'une seine de plage ont été énumérés, identifiés, triés selon l'âge (jeunes de l'année et adultes) puis remis à l'eau. De plus, des données sur l'habitat de ces espèces ont été recueillies telles que la température de l'eau, la salinité, la teneur en oxygène dissous et le pourcentage de recouvrement par les plantes et les algues une fois par mois. De plus, la taille du grain, le % de la teneur en eau et de la teneur en matières organiques du substrat ont été recueillies une fois par an, soit en septembre. Deux échantillons d'eaux ont également été collectés à chaque station et analysés pour déterminer le contenu en nutriment. Le présent rapport résume les données physiques et biologiques des emplacements principaux des estuaires étudiés en 2006. Cette année, un peu moins de quatre cents milles animaux ont été comptés et 35 différentes espèces ont été identifiées. Pour pouvoir vérifier l'hypothèse selon laquelle ces données reflètent la qualité de l'environnement estuarien, plusieurs années de données devront être étudiées afin de détecter les tendances temporelles et spatiales qui pourraient exister. On espère que le programme s'avèrera une méthode simple de caractérisation de la santé estuarienne qui sera à la fois utile et facile à appliquer pour les groupes communautaires.

1.0 INTRODUCTION

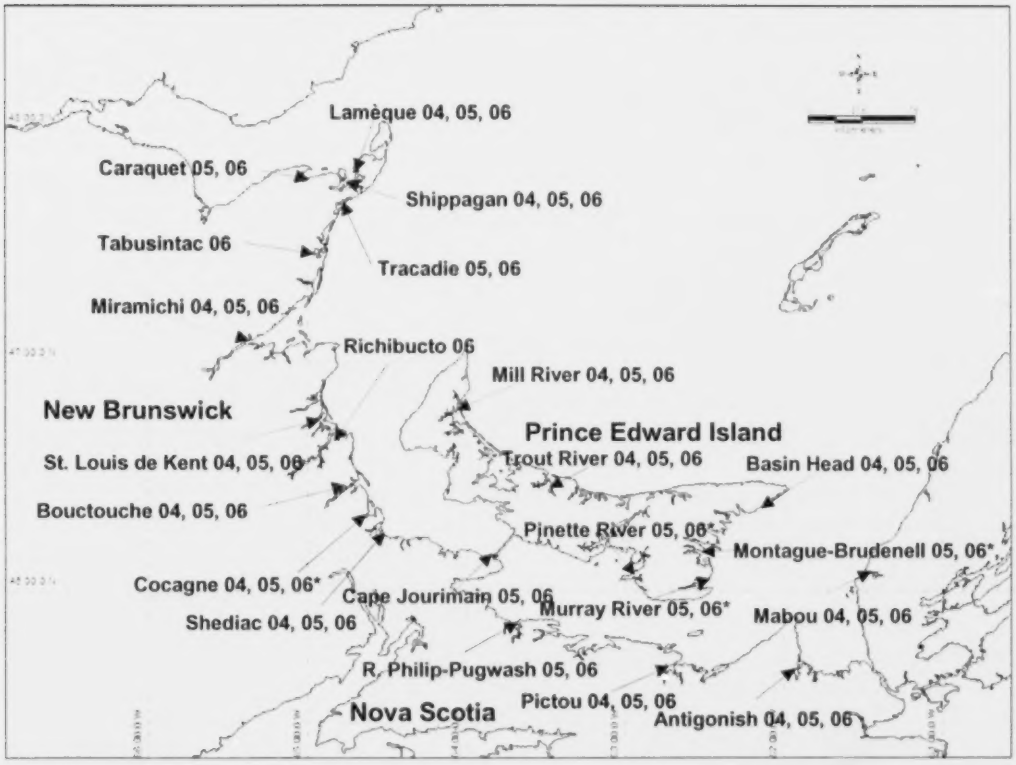
1.1 Background

In the Canada Oceans Strategy document (COS, 2002), Fisheries and Oceans Canada (DFO) established its commitment to work collaboratively with local stakeholders to "*establish marine environmental quality guidelines, objectives and criteria respecting estuaries, coastal waters and marine waters.*" During 2003 and 2004, the Stewardship and Aquatic Ecosystem Sections of DFO Gulf Region integrated their planning priorities to develop a practical monitoring program that would assist in determining the ecological health of estuaries in the southern Gulf of St. Lawrence (sGSL) as outlined in Canada's Stewardship Agenda (2003). The outcome was the development of the Community Aquatic Monitoring Program (CAMP) outlined in detail in the first report (Weldon et al. 2005). One of the aims of the program is to determine if a relationship exists between the health of an estuary and/or a coastal shoreline and the diversity and abundance of conspicuous invertebrate and fish species which utilize this ecosystem. This concern over animal abundance is highlighted by a regional concern over the decline in eelgrass populations (Hansen 2004) and the dependency of many of the estuarine animals on eelgrass as a primary habitat. One hypothesis being tested by CAMP is that an estuary which has been degraded by human activity may have fewer species and different abundance of individuals than a healthy, undisturbed estuary.

Methods and protocols to implement the CAMP approach were chosen after reviewing a wide variety of methods for evaluating estuarine health and population dynamics (Karr 1981, Methven et al. 2001, Whitfield and Elliot 2002). Standardized methodology continues to be followed in 2006 (see Weldon et al. 2005). This report will provide an overview of the CAMP results in 2006 and very briefly discuss some of the similarities and differences with outcomes of the 2004 - 2005 field seasons. A subsequent report will provide a more in-depth comparison of four years of CAMP data.

1.2 Where has CAMP taken place?

CAMP is a long term community aquatic monitoring program used to determine the ecological health of estuaries and coastal shorelines in the sGSL region. It was determined that to become a baseline location, an estuary or coastal shoreline would be sampled monthly during the spring and summer months (May - September) (5 times) at 6 chosen stations. This resulted in establishing eight sample estuaries in NB, three sample estuaries in NS and three sample estuaries in PEI in 2004. This expanded to eleven in NB, four in NS and six in PEI in 2005 as illustrated on the map below. In 2006, one baseline location (Cocagne) in NB did not have the capacity to maintain full baseline status but two others were added (Tabusintac and Richibucto) resulting in a total of 12 baseline for 2006. While there was no change in Nova Scotia, PEI was only able to maintain three baseline locations in 2006 though the other three did sample near the end of the season.



* refers to locations that were sampled 3 or 4 of the 5 months (almost baseline)

Figure 1. CAMP baseline monitoring locations (2004 - 2006) for NB, NS and PEI. Each arrow shows the location of a baseline sampling estuary that includes six sample stations.

The CAMP program continues to involve several partnerships including DFO Oceans and Science Division, DFO Area offices, Universities, various environmental organizations and local estuary community watershed groups, all based throughout the Gulf Region.

The groups who participated in 2006 include:

New Brunswick

- Partenariat pour la gestion intégrée du bassin versant de la baie de Caraquet
- Coalition pour la viabilité de l'environnement des havres de Shippagan et les Îles Miscou et Lamèque
- L'association des bassins versants de la Grande et Petite rivière Tracadie
- Tabusintac Watershed Association
- Miramichi River Environmental Assessment Committee
- Friends of the Kouchibouguacis River
- Elsipogtog First Nation Fisheries Management
- Southeastern Anglers Association

- Pays de Cocagne Sustainable Development Group
- Shediac Bay Watershed Association
- Cape Jourimain Nature Centre

Prince Edward Island

- Mill River Watershed Improvement Committee
- Trout River Environmental Committee
- Basin Head Lagoon Ecosystem Conservation Committee
- Southeast Environmental Association
- Montague Watershed Improvement Committee
- Students from the University of Prince Edward Island Biology Department

Nova Scotia

- Friends of the Pugwash Estuary
- Cumberland County Rivers Association
- Fresh Air Outdoor Adventure Society
- Mabou Harbour Coastal Management Planning Committee
- Students from the St. Francis Xavier University Biology Department and program in Integrated Studies in Aquatic Resources (ISAR).

Participation of community groups is a fundamental strength of the CAMP program, as communities share the responsibility of volunteering their time to monitor estuaries and coastal shorelines in their area. As they often have several projects related to the estuary, their work is instrumental in demonstrating and initiating fundamental stewardship principles.

2.0. MATERIALS AND METHODS

Monthly daytime sampling was done from May to September for the baseline sites. This included two new locations in NB in 2006, namely Tabusintac and Richibucto. In this report a location (or site) refers to the specific estuary or coastal sample area and a station refers to one of the 6 areas where beach seines sampled the shoreline community. Data on invertebrates and fish species, macrophytes, water quality and benthic substrate were collected at 108 baseline sampling stations throughout the provinces of NB, NS and PEI. A standardized beach seining method was used to collect and monitor the presence and abundance of estuarine species. Physical data included the use of a quadrat for vegetation cover, YSI meter readings to record temperature, salinity and dissolved oxygen, a sediment collection and a water sample collected for nutrient analysis. Detailed methodology and protocols are described in more detail in Weldon et al. (2004).

2.1 Training

The new training and refresher review program for CAMP participants takes place in May and is a combination of theory and practical sessions. The theory session includes an hour long presentation on CAMP which includes background, an outline of the methodology, an introduction to the equipment, training on use of the field data collection sheets and a review

of the identification of species sampled during the field season. The training regime has been slightly modified depending on the experience of past NGO coordinators and the need to train new employees and/or volunteers.

The practical session involves training to familiarize participants with the proper use of equipment, standardized techniques and proper identification of fish, crustaceans and plant species with an actual on-site beach seine collection. After a beach seining, the volunteers identify the contents of the beach seine while DFO trainers and NGO coordinators assist with verification and identification. A folder for plant and animal identification with the most commonly encountered species, mostly referenced from Scott and Scott (1988), was prepared and provided to each community group

2.2 Site Selection

In 2006, NGO's returned to the exact same estuary or coastal location to repeat the sampling regime at the same stations of the past year. New baseline estuary sites were added in 2006 using protocols identical to those of the 2004 - 2005 collections (Weldon et al. 2004).

2.3 Fish Identification

When difficulties with identification arose, groups could refer to the CAMP identification guide for clarification, or collect a specimen for identification. One option was to get the unknown plant or animal back to the local Area Office or DFO HQ for identification. The unknown species would be put on ice and frozen or otherwise preserved upon return to the NGO field station. Guides such as Peterson Atlantic Coast Fishes and Atlantic Seashore field guides were made available and distributed to community groups to be used to assist with identification. Groups were also encouraged to take a quality digital photograph to assist with later identification for any unknown species.

2.4 Macrophytes

A 50 cm x 50 cm quadrat, divided into four equal sub-quadrants, was used to estimate macrophyte percentage cover at each sample station. The quadrat was thrown three times, across the sample area from left to right at middle depth. The data sheet was used to record the approximate percentages of the dominant plant and algal types. The use of this quadrat method was possible only when the water column was not turbid. Wind and wave action stirred up the sediment and made the percentage cover evaluation difficult in some cases.

Volunteers also included a general description of the sample area by taking notes of the overall dominant macrophytes present, their approximate cover percentage and location in reference to the shore.

2.5 Physical Measures

YSI meter model 85 was used to measure three physical components of water: temperature (± 0.1 C°), dissolved oxygen (± 0.1 mg/L) and salinity (± 0.1 ppt). Meter readings were taken

either before (adjacent to the sweep site) or after the beach sweep (within the net area). The YSI probe was submerged approximately at mid-depth in the vicinity of the center of the sample area.

Also in 2006, Vemco continuous temperature monitoring probes were deployed for most of the sampling season. This was done in 2005 by DFO personnel with a NGO representative or with Area Office coordinator assistance. In 2006, NGOs were given the probes to place within their estuary or coastal location. For the most part, they attached the probe one meter below the surface to a temporary channel marker. In other cases, the probe was attached to a fixed structure such as a wharf or dock one meter below the low water mark. Recovery was successful for about 60% of the probes. Other probes were considered lost after every effort was made to locate them.

2.6 Substrate

In September, a sample of benthic substrate was collected from each sample station to analyze moisture content, organic content and grain size of the sediment. Using a garden trowel, a sample of the surficial ten cm layer was obtained from within the seine area, bagged and returned for freezing at -20°C and stored for later analysis at the Gulf Fisheries Center. From each frozen sediment sample, a thawed portion (100 ± 20 grams) was removed and placed in an aluminum pan.

In the laboratory, moisture content was determined as the difference in weight before and after drying at 70°C for 24 h (standardized time). Organic content was calculated as the difference in weight before and after burning the sediments in a muffle furnace at 500°C for one hour (standardized time). (Note that the burning time was decreased to one hour from three hours in 2005). Grain size distribution per sample was determined from 10 min shaking (standardized time) with a mechanical sieve shaker with six different sieve sizes: >2 mm (very coarse sand), >1 mm (coarse sand), >500 µm (medium sand), >250 µm (fine sand), >125 µm (very fine sand), >63 µm (coarse silt) and <63 µm (silt) (Higgins and Thiel 1988). The mean grain size (MGS) was then calculated from the cumulative frequency curves established with the grain size distribution.

2.7 Nutrient Analysis

In 2006, each group was supplied with twelve 30 ml water bottles to collect two replicate water samples at each station in their location. All twelve bottles were numbered and on the date of collection, matched with the station. The samples were collected on the sampling day in September and stored in a cooler bag with ice. Upon return to home base, they were frozen to await transport back to DFO where they were then sent to Halifax. The Bedford Institute of Oceanography physical parameter section completed the chemical analysis for nutrient content (ammonia, nitrate, nitrite, phosphate and silicate) during the winter. Results were made available in the fall of 2007. Detailed protocols for the treatment of the water samples will be presented in Theriault and Courtenay, 2008 (unpublished report).

2.8 Permits

Each group was able to apply on-line to acquire a species sampling permit for scientific purposes. These are available from DFO Gulf region at the following location:

https://www.glf.dfo-mpo.gc.ca/fam-gpa/bssp-saps/s52/form-e.php?form_lgE=e

Persons listed as part of the community group on the Section 52 permit are authorized to collect, count and release fish species commonly found in estuarine locations. The permit also allowed them to collect and transfer species that required further identification.

3.0. RESULTS

Descriptive statistics were used to examine the CAMP data and determine the relative abundance and species richness for sampling sites in each of the Maritime Provinces.

The total abundance values were determined by adding the totals for each species for the five months sampled of the season at each CAMP estuary or coastal site. Species richness was calculated by determining the mean number of different species captured across all six stations located within a CAMP site, for each month sampled. In addition, the species richness was averaged across all stations for each of the five months sampled at each baseline site. Presenting the data in this way allows for comparisons among all the estuarine and coastal shoreline sample sites. Abundance of a particular species or grouped species of invertebrate or fish can be compared across sites and stations. This information is also available in graphic form on posters developed for each geographical region of the Northumberland Strait.

3.1 Fish and Crustaceans

This section will discuss sampling results for locations with four to five complete months of sampling data. This includes the provinces of NB, NS, and PEI for the following 19 sites; Jourimain, Scoudouc, Cocagne (4 months), Bouctouche, Saint Louis de Kent, Richibucto, Miramichi, Tabusintac, Tracadie, Lamèque, Shippagan, and Caraquet (NB); River Philip-Pugwash, Pictou, Antigonish, and Mabou (NS); and Mill River, Trout River, Basin Head (PEI). Partial results for the three southerly sites in PEI are also included.

For the 2006 sample season, a total of 396,417 fish and crustaceans were counted from eleven baseline (plus one 4-month almost baseline) estuaries/coastal shorelines within NB, four in NS and three in PEI (plus three stations that sampled 3 of 5 months).

There were 35 different species of fish and crustaceans identified during the 2006 sample season, twenty-nine of those species were fish and six were crustaceans (Appendix 1). Species not noted in 2005 were added to the bottom of the list.

The six common species of crustaceans were; sand shrimp (*Crangon septemspinosa)*, grass shrimp (*Palaemonetes vulgaris*), rock crab (*Cancer irroratus*), green crab (*Carcinus maenas*), lady crab (*Ovalipes ocellatus)* and mud crabs (*Xanthidae sp.*).

Interestingly, the most abundant fish and crustacean species were very similar for New Brunswick, Nova Scotia and Prince Edward Island. They were, in order of most abundant;

sand shrimp (*Crangon septemspinosa*), both mummichog (*Fundulus heteroclitus*) and killifish (*Fundulus diaphanus*) grouped as *Fundulus* sp., 4-spine stickleback (*Apeltes quadracus*) and Atlantic silverside (*Menidia menidia*).

The ten most abundant species or species groups for each province/zone are graphed below (Figures 2 - 6B) to show the abundance relationship among the three sections in New Brunswick, namely northeastern, central and southeastern sites (Fig. 2 – 4A), Nova Scotia (Fig 5 & 5A) and Prince Edward Island sites (Fig. 6, 6A & 6B). Within the ten categories of species, the 'other' category pools the remaining less abundant species which sometimes represents large number of certain species at specific stations (eg. pipefish, smelts, striped bass). Because groups have collected up to 35 different species, the decision was made to group less numerous individuals rather than try to illustrate 35 graphs (Weldon et al. 2005). For each month, average species richness per beach seine haul was calculated across the six stations. The mean and 95 % confidence interval for these monthly estimates of species richness were plotted for each estuary or coastal location.

The legend for each graph (Figures 2 - 6) remains consistent for this report as it has for the previous two publications (Weldon et al. 2005, 2007). In the legend, "Stickle" refers to stickleback and "Killi" refers to killifish.

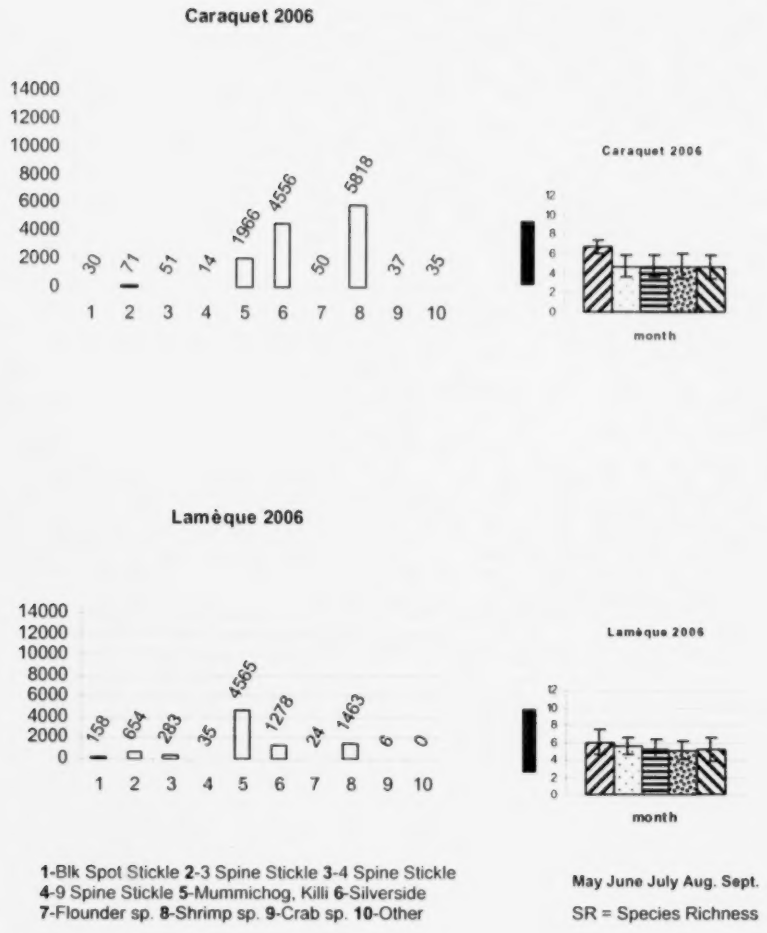


Figure 2. Total cumulative number of adult animals for the 10 most abundant species or species groups in Caraquet and Lamèque (NB) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

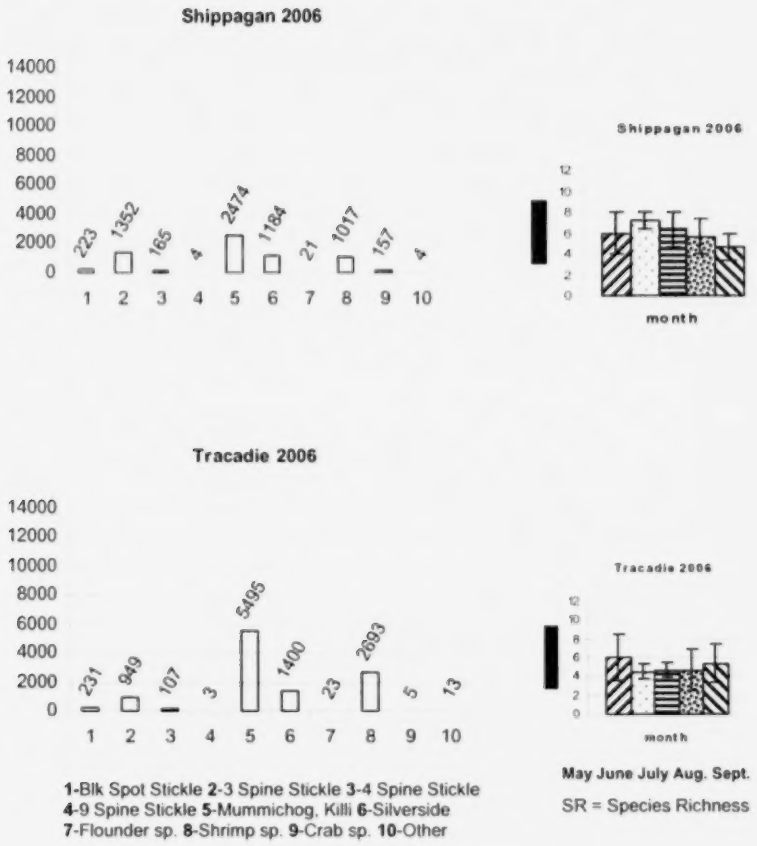


Figure 2A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Shippagan and Tracadie (NB) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

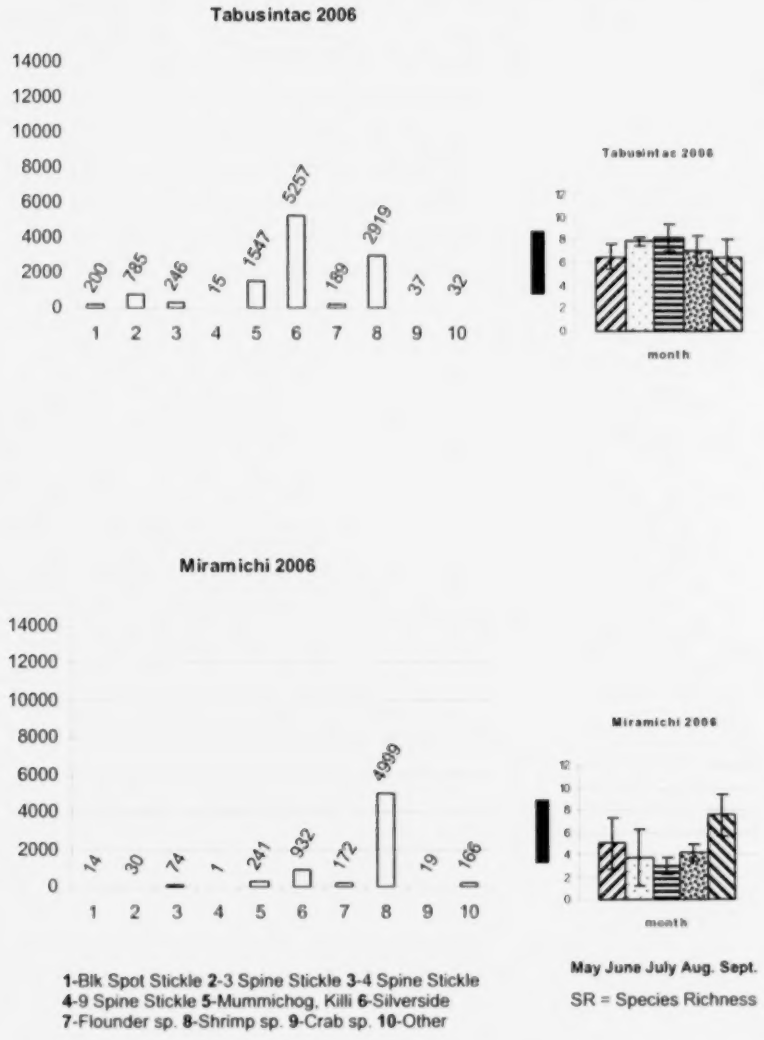


Figure 3. Total cumulative number of adult animals for the 10 most abundant species or species groups in Tabusintac and Miramichi (NB) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

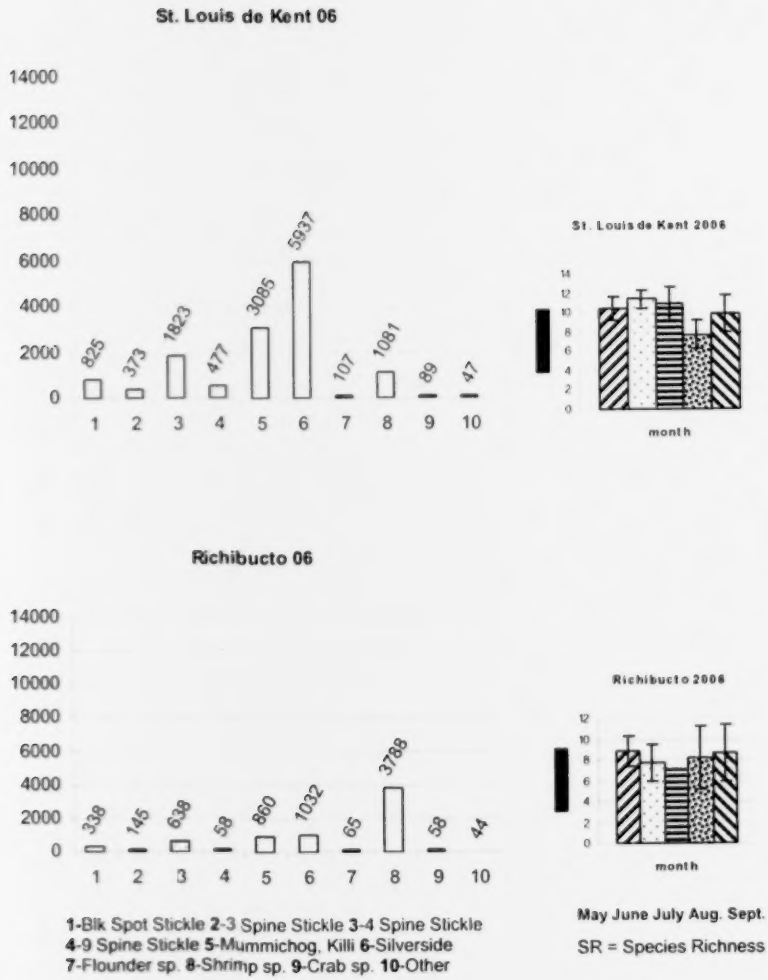


Figure 3A. Total cumulative number of adult animals for the 10 most abundant species or species groups in St. Louis de Kent and Richibucto (NB) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

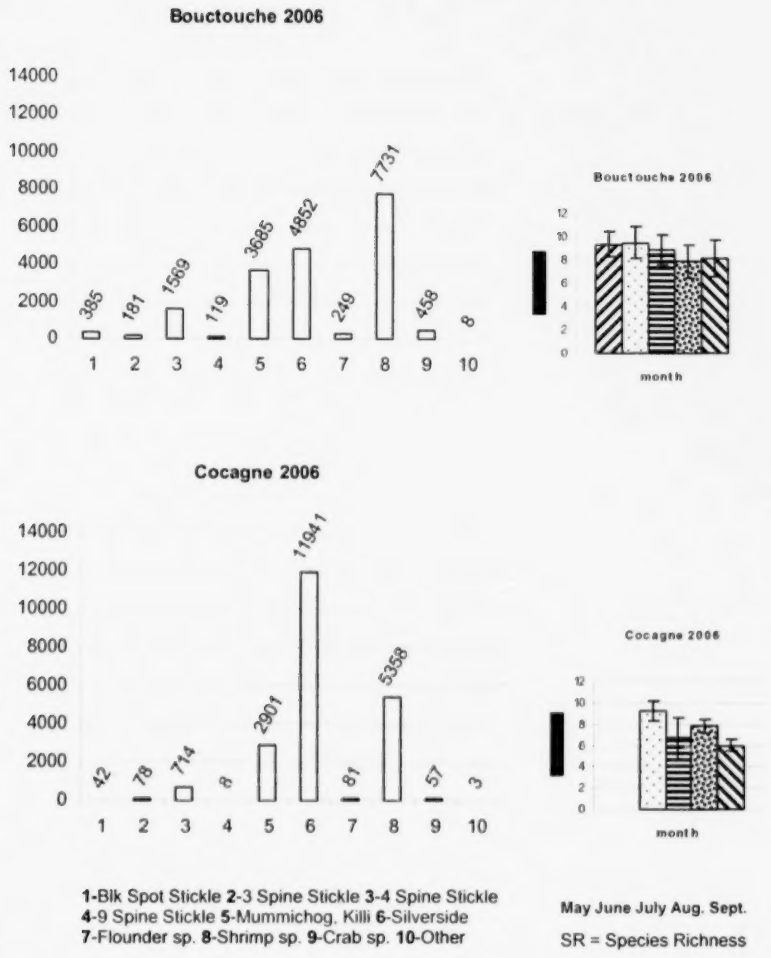


Figure 4. Total cumulative number of adult animals for the 10 most abundant species or species groups in Bouctouche and Cocagne (NB) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

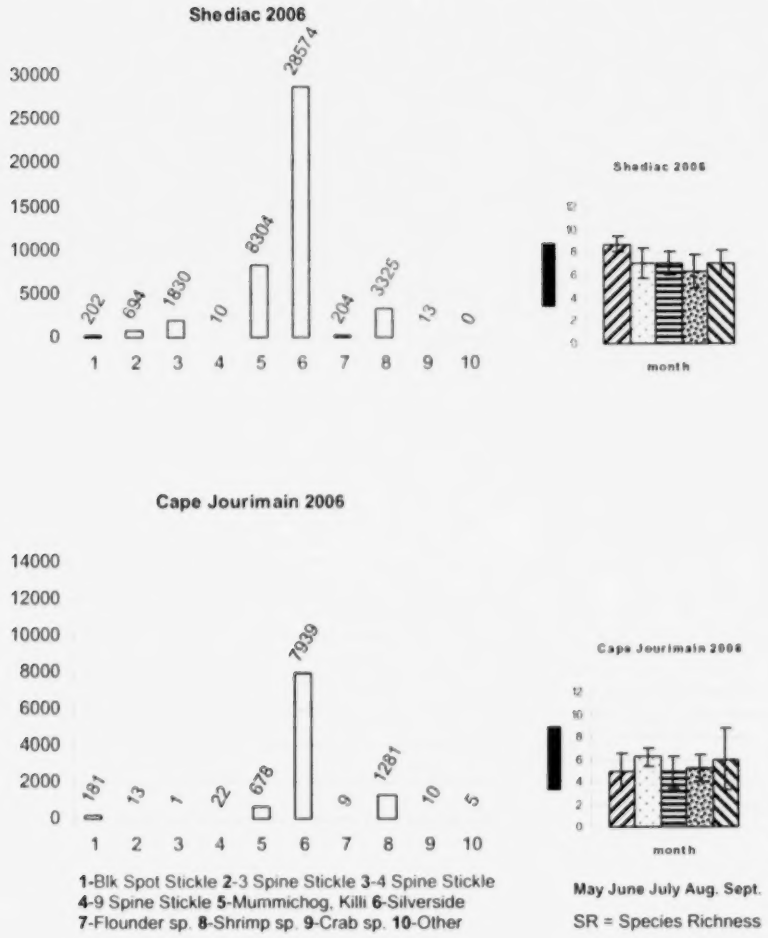


Figure 4A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Shediac and Cape Jourimain (NB) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

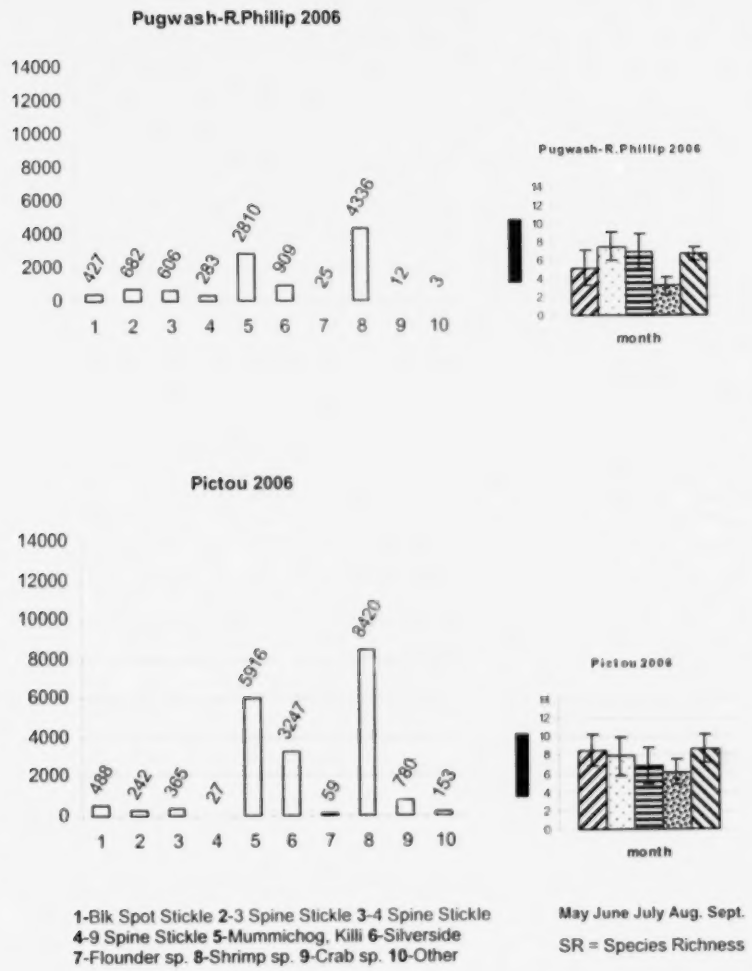


Figure 5. Total cumulative number of adult animals for the 10 most abundant species or species groups in Pugwash-R. Phillip and Pictou (NS) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

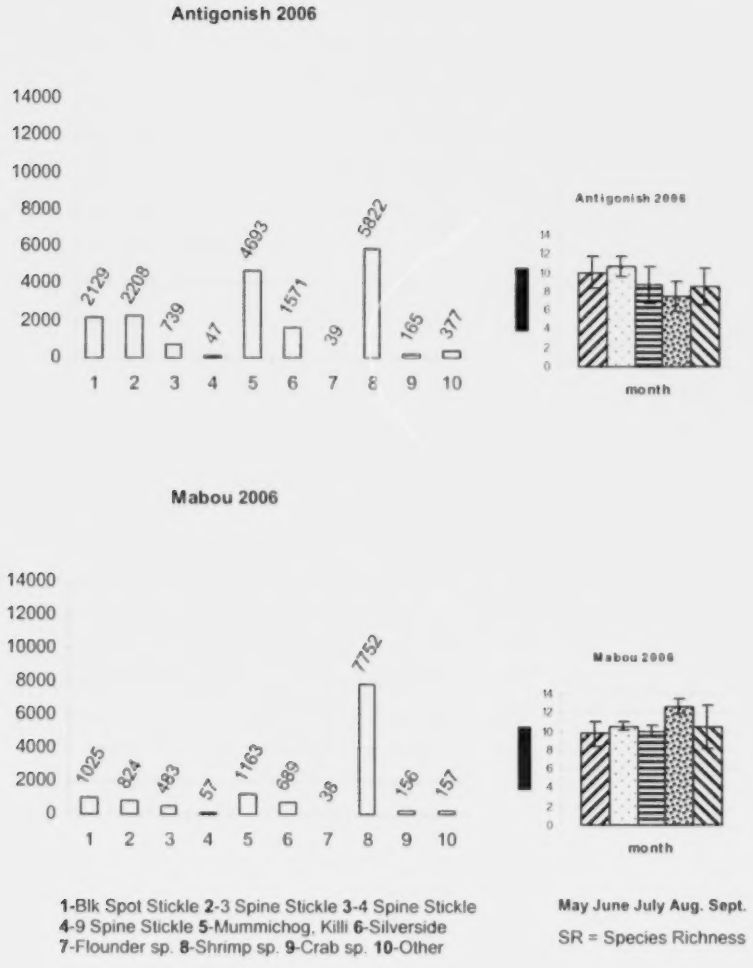


Figure 5A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Antigonish and Mabou (NS) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total number of species taxa) is also shown among the months (n = 6 stations per bar).

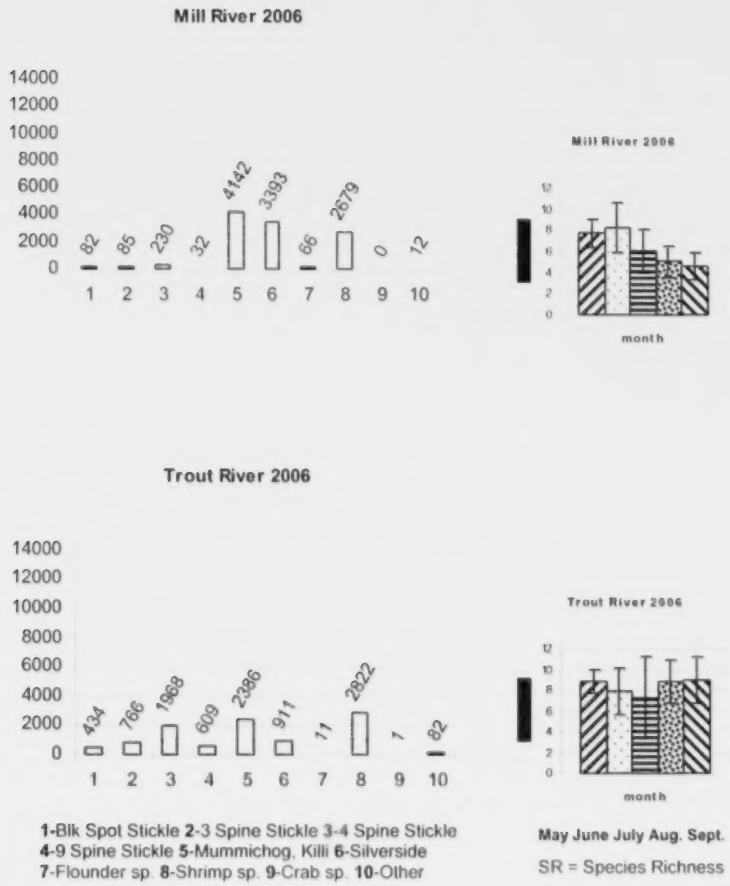


Figure 6. Total cumulative number of adult animals for the 10 most abundant species or species groups in Mill River and Trout River (PEI) sampled over 5 months in 2006. Mean (95 % confidence interval CI) species richness (total 6 number of species taxa) is also shown among the months (n = 6 stations per bar).

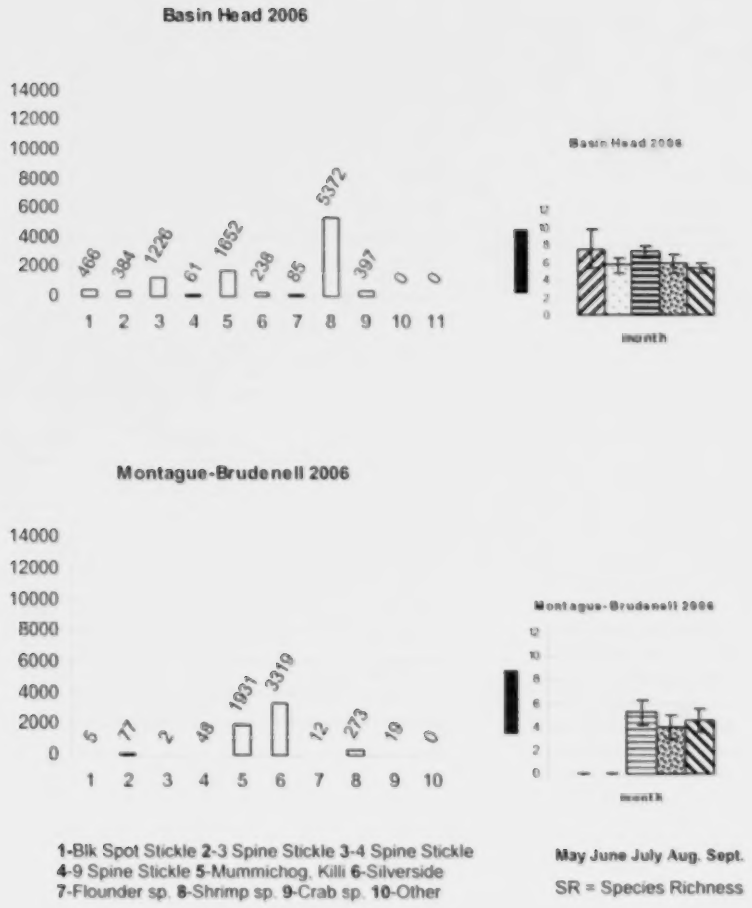


Figure 6A. Total cumulative number of adult animals for the 10 most abundant species or species groups in Basin Head and Montague - Brudenell (PEI) sampled over 5 and 3 months respectively in 2006. Mean (95 % confidence interval CI) species richness (total 6 number of species taxa) is also shown among the months (n = 6 stations per bar).

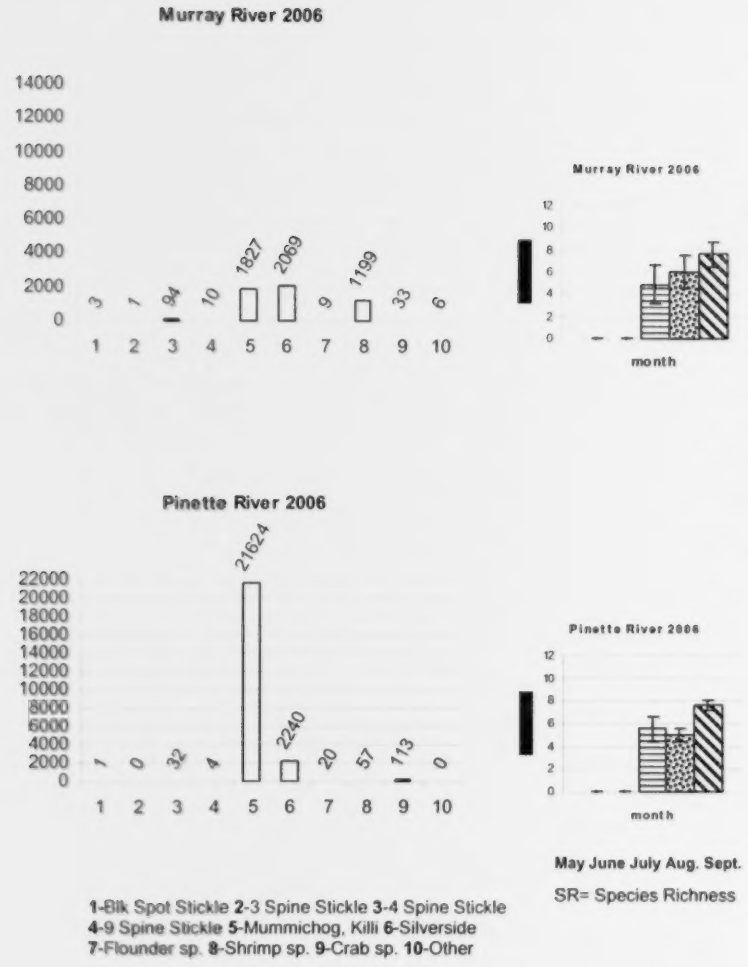


Figure 6B. Total cumulative number of adult animals for the 10 most abundant species or species groups in Murray River and Pinette River (PEI) sampled over 3 months in 2006. Mean (95 % confidence interval CI) species richness (total 6 number of species taxa) is also shown among the months (n = 6 stations per bar).

In northeastern NB (Figures 2 & 2A), the four most abundant species in Caraquet, Lamèque, Shippagan and Tracadie were mummichog, shrimp, silverside and three spine sticklebacks. *Fundulus* species were the most abundant at all locations except Caraquet where shrimp was the most abundant species group. The threespine stickleback counts were higher in all locations compared to the fourspine and the blackspotted sticklebacks. Lamèque had the lowest overall totals compared to the other three locations.

Mean species richness was highest in the spring except in Shippagan where the June sample was highest, though compared to the rest of the province, numbers were generally lower.

In central NB (Figure 3 & 3A), Tabusintac and Richibucto joined Miramichi and St. Louis de Kent (Kouchibouguacis) as the baseline locations in 2006. Silversides were the most abundant species in Tabusintac and St. Louis de Kent. Shrimp species were most abundant in the Miramichi and Richibucto. Silversides lead abundance totals for all fish species in all four locations. In the stickleback category, fourspine sticklebacks lead abundance numbers in all locations except Tabusintac where threespine numbers were highest. In the "other" category, striped bass juveniles were most abundant in Miramichi where 162 individuals were found in August.

Mean species richness showed no pattern with monthly numbers highest in July (Tabusintac), September (Miramichi), June (St. Louis) and May (Richibucto). A similar trend to 2005 data was evident in that species richness was higher overall in central NB when compared to northeast NB.

In southeastern NB (Figure 4 & 4A), Bouctouche, Cocagne, Shediac and Cape Jourimain maintained baseline status. Silverside numbers were highest at all sites except Bouctouche where shrimp species were most abundant. Silversides were the most abundant fish species at all locations. Among the stickleback species, the fourspine was highest in abundance at all locations except Cape Jourimain where the black spotted had highest abundance totals. Cape Jourimain is more of a coastal sample area compared to the other sites which are estuaries which might help explain the lower overall abundance totals per species.

Mean species richness was highest in May and June in all four locations, though the drop later in the season was no greater than one unit. Mean species richness in the southeast was slightly less than central NB but greater than northern NB.

In Nova Scotia, Pictou, Antigonish, Mabou and River Phillip-Pugwash maintained baseline status in 2006 (Figure 5 & 5A). These locations maintained a full sampling schedule because of regular assistance of biology students from St. Francis Xavier University. Sand shrimp were highest in numbers in all locations. *Fundulus* species were second in abundance at all locations. Among the four stickleback species, threespine numbers were highest in River Philip-Pugwash and Antigonish, and black spotted dominated numerically in Pictou and Mabou. Fourspine sticklebacks were third in numerical abundance in all locations except in Pictou where they were the second most abundant. Sandlance and pipefish were dominant in total number in Antigonish in the "other" category.

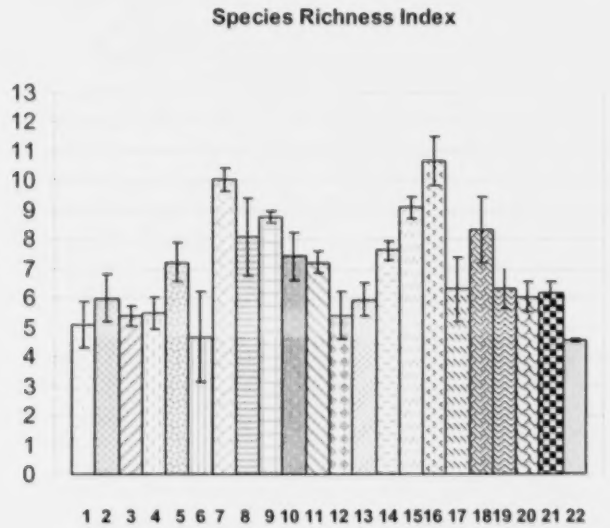
There were some large fluctuations in species richness in Nova Scotia throughout the sampling months. Overall comparisons of mean species richness illustrate lower values (5 - 7.5) for R. Philip-Pugwash to a higher range of 10 to 13 for Mabou. The others were in-between and the average for Nova Scotia was around seven.

In Prince Edward Island (Figure 6 & 6A), Basin Head, Trout River and Mill River maintained their baseline status in 2006. The Southeast Environmental Association (SEA), completed CAMP at the Pinette, Murray and Montague-Brudenell river estuaries for three months in 2004, achieved full five month baseline status in 2005, but completed only three months again in 2006.

Comparing the three baseline locations in PEI, Trout River and Mill River had approximately the same abundance of collected species overall and both were higher than Basin Head. Sand shrimp were most abundant in Basin Head and Trout River. *Fundulus* sp. had the highest total in Mill River and was second in abundance in the Trout and Basin Head locations.

For the stickleback species, fourspine stickleback abundance was highest in Mill River, Trout River and Basin Head. The threespine stickleback abundance was second highest in Mill and Trout River locations and the blackspotted second at Basin Head. Trout River had a very high number of ninespine sticklebacks compared to the other two locations. For the SEA sample estuaries, *Fundulus* species and silversides dominated the total numbers in all three locations.

Mean species richness showed no consistent pattern over the months, though higher numbers generally occurred in May. Species richness comparisons showed a slight drop as the season progressed in Mill River and Basin Head but remained steady in Trout River.



(NB) 1- Caraquet **2-** Shippagan **3-** Lamèque **4-** Tracadie **5-** Tabusintac
6- Miramichi **7-** St. Louis de Kent **8-** Richibucto **9-** Bouctouche **10-** Cocagne
11-Shediac **12-** Cape Jourimain **(NS) 13-** Pugwash -R. Phillip **14-** Pictou
15- Antigonish **16-** Mabou **(PEI) 17-** Mill River **18-**Trout River **19-** Basin Head
20- Pinette R. **21-** Murray R. **22-** Montague-Brudenell R.

Figure 7. The mean species richness with a confidence interval at ± 95% (n = 5 months for each bar; total species observed at all six stations summed for each month) for 18 baseline estuary locations in the Gulf of St. Lawrence over a 5 month period (n = 4 for number 10, n = 3 for numbers 20, 21 & 22).

Figure 7 provides an average species richness of all 6 sample stations, for all months for each of the 18 baseline estuaries or coastal shoreline locations. The species richness for all five months was averaged to arrive at the reference value shown in the graph. At this time the combined data provide a baseline reference point. When more information is available, environmental science personnel will examine the successive year data for patterns and trends.

In New Brunswick, St. Louis de Kent had the highest average species richness for the five month sampling period at 10.000 species ± 0.396 (SD), followed closely by Bouctouche (8.733) and Richibucto (8.060). The lowest average species richness was in Miramichi at 4.667 species ± 1.529.

In Nova Scotia, Mabou Harbour had the highest species richness value at 10.667 ± 0.828 (SD) followed closely by Antigonish with 9.067 ± 0.371 (SD) and River Philip - Pugwash was lowest at 5.933 species ± 0.558 (SD).

In PEI, Trout River had the highest mean species richness value at 8.3 species ± 1.114 (SD). Basin Head and Mill River had almost identical species richness values at 6.3 with different standard deviation values of ± 0.688 and 1.387 respectively. For the three locations in the southeast (only three months sampled), the Montague - Brudenell system has the lowest value at 4.6 species ± 0.060 (SD). The other two locations, Pinette and Murray rivers were slightly higher at 6.0 and 6.1 respectively.

3.2 Macrophytes

The dominant vegetation type, when considering all sites, if present, was submerged eelgrass beds. Usually the eelgrass bed was located in the outer 1/5th or just beyond the sample sweep area. Generally, upper estuary sites in the river system contain more eelgrass beds than the outer portion that is closer to the mouth or associated with a beach area. If a vegetation bed was present, the number of fish and invertebrates collected was generally higher as more habitat for pelagic species was available. Sites with larger rocks are likely to include species of rockweed (usually *Fucus vesiculosus*). Other abundant macrophyte vegetation included filamentous green algae (*Cladophora sp.*) and sea lettuce (*Ulva lactuca*). In northern NB and at a few NS sites hollow green weed (*Enteromorpha intestinalis*) was noticeable but not abundant. On many occasions, NGO volunteers have found floating unattached pieces of kelp species (*Laminaria*) and green fleece (*Codium fragile*) in the net sweep. These species are usually attached by a holdfast in deeper water. Vegetation type is important as it defines the variety of available habitats. Preference of YOY pelagics and juvenile crustaceans for protective cover from predators translates into greater numbers when vegetation is present.

Percent vegetation cover was estimated using the sampling grid as described in Weldon et al. (2005). When using the grid was not possible, usually due to wind stirred turbidity issues, volunteers estimated the overall vegetation cover by looking at the 225 m^2 area of beach seine sweep and providing a best possible estimate.

Table 1. Summary of the dominant bottom sediment type observed for six stations of each estuary location and the mean percent range of vegetation cover of individual stations (total stations = 6, mean of 5 monthly samples for percentages)

N.B.	# Sites Mud	mean % Vegetation Mud	# Sites Mud-Sand	mean % Vegetation Mud-Sand	# Sites Sand	mean % Vegetation Sand	# Sites Sand-Rock	mean % Vegetation Sand-Rock	# Sites Rock	mean % Vegetation Rock
Caraquet	2	5 - 30	0	0	2	5 - 25	1	0	1	20 - 70
Lamèque	0	0	4	5 - 30	1	5 - 35	1	5 - 40	0	0
Shippagan	0	0	5	5 - 35	1	0	0	0	0	0
Tracadie	0	0	2	5 - 55	1	0 - 5	2	5 - 30	1	10 - 50
Tabusintac	0	0	5	0 - 15	0	0	1	0 - 15	0	0
Miramichi	0	0	1	0	1	0	3	0 - 10	1	0 - 5
St Louis	3	10 - 50	3	0 - 50	0	0	0	0	0	0
Richibucto	0	0	1	10 - 35	3	5 - 50	2	5	0	0
Bouctouche	1	0 - 60	4	10 - 40	1	5 - 20	0	0	0	0
Cocagne	0	0	1	10 - 30	4	5 - 10	1	0	0	0
Shediac	1	10 - 40	3	10 - 30	2	5 - 10	0	0	0	0
Jourimain	0	0	1	0 - 10	5	0 - 5	0	0	0	0
N.S.										
R. Phil-Pugwsh	4	0 - 40	0	0	2	5 - 40	0	0	0	0
Pictou	0	0	2	0 - 20	2	0 - 5	2	5 - 30	0	0
Antigonish	1	5 - 10	2	0 - 40	1	0 - 5	2	10 - 50	2	0 - 45
Mabou	2	10 - 75	0	0	0	0	1	10 - 20	3	10 - 40
P.E.I.										
Mill River	1	50 - 75	0	0	5	10 - 40	0	0	0	0
Trout River	3	10 - 70	0	0	2	10 - 50	1	10 - 30	0	0
Basin Head	1	20 - 60	3	10 - 50	2	10 - 75	0	0	0	0
Pinette	0	0	2	5 - 40	3	0 - 25	1	10 - 25	0	0
Murray	0	0	2	0 - 10	4	0 - 10	0	0	0	0
Mont.-Bruden	0	0	2	10 - 50	4	0 - 30	0	0	0	0

The percent vegetation cover is presented as averages and/or best estimates or an average range for the five months sampled. These vegetation cover percentages fluctuated throughout the season and do show variation from year to year. Percent vegetation cover is a qualitative measure because some is attached (eelgrass and rockweed) and some is floating as was observed with sea lettuce. The spring observations have lower values for vegetation but as a season progressed, the vegetation present generally increased. When a range is indicated in the above table it generally reflects more vegetation due to plant growth during the season and influx of floating material such as sea lettuce.

The quadrat method described in Weldon et al. (2005) is effective when the water has not been stirred up. In 2006, it was suggested that the quadrat be thrown parallel to the shore at a mid depth from shore, usually at a distance where the bottom could still be seen. The NGO's

were instructed to make a detailed record of the characteristics of the bottom profile for each station in May so comparisons could be made as the season progressed.

3.3 Substrate

In September, one sediment sample was taken at every sample station at all locations. The three dominant sediment types were sand and mud or a combination of both. The sediment analysis was completed in the fall by lab technicians at DFO Gulf region. A more detailed description of the procedure is included in Weldon et al. 2005. Table 1 also contains information related to the dominant station substrate for each location. In New Brunswick, the location with combined most mud (3) and mud - sand sites (3) was in St. Louis de Kent. Tabusintac and Shippagan were close behind with five mud – sand stations. The sandiest locations were in Cocagne and Cape Jourimain, though Cocagne had some mud at the outer edge of the beach seine area. The majority of the stations were characteristically sandy close to shore and muddy farther out. Often the mud was encountered only when sampling occurred at a lower tide. In Nova Scotia, mud or mud - sand occurred in half the stations at all locations except Pictou which had more sand and rock. Prince Edward Island locations were dominated by sandy substrates, though Trout River has three mud dominated stations.

Table 2. Summary of average % organic content (± S.D.), % moisture content (± S.D.), and mean grain size (MGS) for the baseline locations (n = 6).

	% Moisture	% Organic	mean Grain Size MGS (mm)
N.B.		**September**	
Caraquet	21.82 ± 2.78	2.81 ± 3.02	0.30 ± 0.13
Lamèque	22.45 ± 2.44	4.28 ± 4.97	0.55 ± 0.41
Shippagan	18.80 ± 5.50	9.57 ± 4.41	0.57 ± 0.34
Tracadie	19.39 ± 6.28	8.00 ± 4.56	0.27± 0.09
Tabusintac	22.31 ± 1.19	8.26 ± 3.67	0.30 ± 0.07
Miramichi	25.27 ± 5.52	1.95 ± 1.02	0.84 ± 0.69
St. Louis de Kent	23.89 ± 3.52	5.02 ± 3.35	0.33 ± 0.20
Richiboucto	21.74 ± 2.79	4.61 ± 2.45	0.46 ± 0.27
Bouctouche	25.00 ± 2.43	4.75 ± 3.42	0.38 ± 0.13
Cocagne	24.12 ± 6.79	1.32 ± 0.97	0.71 ± 0.51
Shediac	23.68 ± 2.96	13.14 ± 10.53	0.28 ± 0.13
Jourimain	18.97 ± 4.28	1.06 ± 1.02	0.65 ± 0.57
N.S.	**% Moist**	**% Organic**	**MGS**
R. Phil - Pugwash	NA	NA	NA
Pictou	21.27 ± 4.23	3.41 ± 4.05	1.06 ± 0.77
Antigonish	20.30 ± 10.93	1.16 ± 0.97	1.50 ± 0.74
Mabou	NA	NA	NA
PEI	**% Moist**	**% Organic**	**MGS**
Mill River	28.18 ± 1.51	1.38 ± 1..23	0.21 ± 0.05
Trout River	34.15 ± 12.26	4.09 ± 4.72	0.25 ± 0.11
Basin Head	26.40 ± 0.60	0.79 ± 0.32	0.26 ± 0.03
Pinette	22.84 ± 3.23	1.90 ± 3.12	0.30 ± 0.07
Murray	22.52 ± 2.31	0.74 ± 0.22	0.38 ± 0.16
Mont.- Brudenell	22.78 ± 1.09	0.50 ± 0.06	0.29 ± 0.08

In New Brunswick, the Miramichi samples had the highest value for percent moisture content, though all sites fell between 18.80 and 25.27. Shediac has the highest percent organic content (13.14) compared to the next nearest in Shippagan (9.57). Mean grain size was lowest in Tracadie with Shediac having the second lowest.

In Prince Edward Island, Trout River had the highest values for percent organic content and percent moisture contents and the second smallest mean grain size. In Nova Scotia, the River Phillip/ Pugwash and Mabou locations have no results in 2006. Pictou has a higher organic content in the sediment than Antigonish.

3.4 Physical Measures

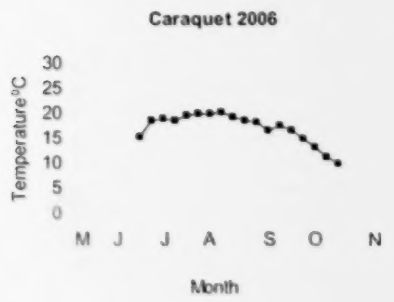
At each sample location and at every station, three physical parameters were measured on each occasion. Readings for temperature, salinity and dissolved oxygen provide a monthly snapshot of conditions each site (Tables 3 - 5).

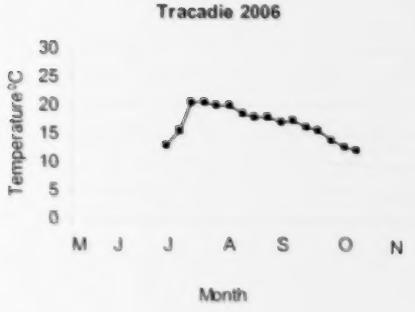
Table 3. Average monthly temperature (^{0}C ± S.D.) per site for the 2006 season (n = 6). (NA = not available) (* 4 stations measured)

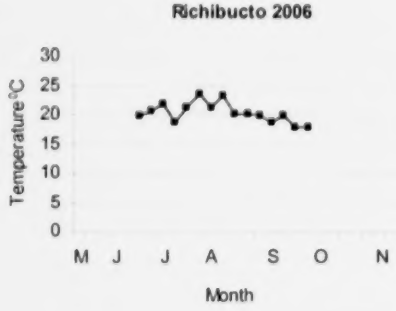
	Temperature (^{0}C) ± S.D.				
N.B.	**May**	**June**	**July**	**Aug.**	**Sept.**
Caraquet	16.0 ± 2.5	20.4 ± 2.7	22.4 ± 3.3	16.2 ± 0.4	12.2 ± 1.6
Lamèque	11.3 ± 0.7	22.3 ± 0.7	20.1 ± 0.2	17.4 ± 1.6	12.0 ± 0.1
Shippagan	15.2 ± 1.4	18.6 ± 0.3	20.1 ± 0.5	19.4 ± 0.7	12.8 ± 0.3
Tracadie	15.9 ± 0.9	20.1 ± 3.2	25.4 ± 2.5	21.3 ± 1.9	13.4 ± 2.1
Tabusintac	12.6 ± 0.8	22.8 ± 0.9	24.6 ± 1.3	19.1 ± 0.7	12.8 ± 0.6
Miramichi	15.0 ± 1.4*	20.7 ± 1.7	21.6 ± 0.9	18.9 ± 0.5	18.0 ± 0.1
St Louis	14.7 ± 0.8	21.6 ± 1.3	25.4 ± 2.2	19.9 ± 0.8	17.7 ± 0.7
Richibucto	13.8 ± 1.6	17.5 ± 1.3	19.6 ± 2.0	20.7 ± 1.6	17.4 ± 1.8
Bouctouche	15.2 ± 0.4	22.5 ± 0.7	23.6 ± 1.0	19.6 ± 0.7	14.8 ± 1.7
Cocagne	NA	21.3 ± 0.9	21.6 ± 1.0	18.2 ± 1.0	14.1 ± 1.4
Shediac	17.7 ± 1.0	22.6 ± 0.5	23.6 ± 1.8	19.5 ± 0.5	17.8 ± 1.1
Jourimain	13.1 ± 2.0	NA	21.1 ± 1.6	18.1 ± 0.9	15.6 ± 0.7
N.S.					
R. Phil-Pugwash	12.6 ± 0.3	18.2 ± 0.6	24.7 ± 2.0	19.8 ± 0.5	12.8 ± 0.4
Antigonish	14.1 ± 2.4	20.6 ± 4.1	21.8 ± 1.4	23.3 ± 1.9	16.5 ± 1.7
Mabou	11.4 ± 0.6	18.4 ± 1.1	24.4 ± 0.6	22.0 ± 0.8	19.4 ± 0.8
Pictou	16.5 ± 3.4	19.7 ± 2.8	24.9 ± 2.5	19.3 ± 0.7	16.0 ± 2.5
P.E.I.					
Mill River	19.6 ± 1.5	23.0 ± 0.8	21.6 ± 0.4	18.8 ± 1.3	14.9 ± 0.4
Trout River	17.0 ± 0.9	21.7 ± 0.7	22.5 ± 1.2	18.6 ± 1.1	13.9 ±1.3
Basin Head	11.0 ± 0.5	16.0 ± 0.6	20.1 ± 0.8	16.3 ± 1.1	13.9 ± 0.3
Pinette	NA	NA	NA	19.3 ± 1.2	17.8 ± 3.3
Murray	NA	NA	21.0 ± 1.9	19.7 ± 2.1	13.4 ± 0.9
Mont.-Bruden	NA	19.6 ± 1.1	19.3 ± 2.5	17.3 ± 1.6	12.5 ± 0.6

Each estuary has its own temperature characteristics. Table 3 reflects the average temperature on the day of sampling after combining all stations in the estuary. There are individual

differences depending on whether the sample site is inner, middle or outer estuary. Temperature was obviously related to seasonal increases and decreases in air temperatures as spring moved to fall; hence the warmest temperatures occurred in July and August. Also, warmest air temperature in the early afternoon could affect water temperature later in the afternoon. In 2006, Vemco continuous temperature minilog probes were deployed in each CAMP estuary/ coastal location. St. Simon was installed before they decided not to proceed in 2006. The loggers were set to record at hourly intervals and the graphed data represent weekly averages. The majority were recovered, but where data are missing, those probes were not recovered. The following graphs represent those weekly averages for those locations where probe information was available.







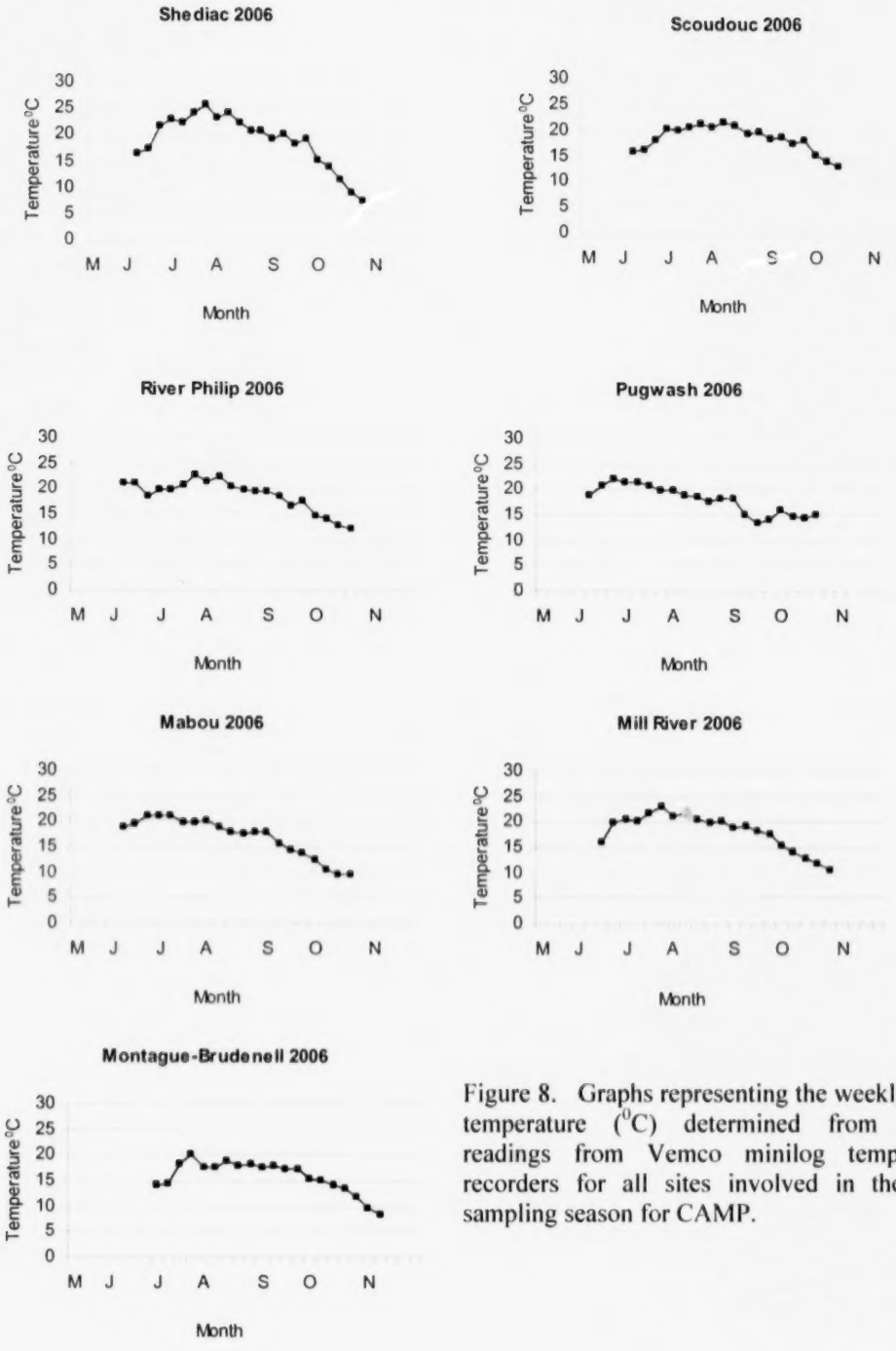


Figure 8. Graphs representing the weekly mean temperature (^{0}C) determined from hourly readings from Vemco minilog temperature recorders for all sites involved in the 2006 sampling season for CAMP.

In New Brunswick, there was a slight drop in the average surface temperature in late June which was most pronounced in Richibucto. Shippagan and Lamèque and St. Simon all showed a similar pattern as expected by their close proximity. All three graphs showed a small drop in early July and early September, followed by an increase before levelling off and starting the usual fall decline. Richibucto showed an up and down fluctuation unlike any other location. Shediac and Scoudouc had a similar pattern to each other, though the Scoudouc graph illustrates a more moderate fluctuation and less extreme high temperatures.

In Nova Scotia, the temperatures for adjacent River Philip and Pugwash regimes showed stable summer levels, a slight drop in mid-September then an increase in late September followed by a slow decline as the fall progressed. Mabou showed a gradual decline starting in August which became slightly more pronounced from September on.

In Prince Edward Island, minilog recovery was only 33 percent as four were lost. The two results above are from opposite ends of the province. Overall, Mill River was warmer and both peaked with their highest readings in late July. After mid-August, both locations show a gradual decline as fall approached.

Values for salinity (Table 4) varied extensively among sites, at different sampling times and within each estuary. However, when monthly averages were examined seasonal variations were not extreme. If the tide was just starting to recede in the upper estuary, the salinity would naturally be higher than if the tide had not come in yet due in part to greater influence from headwaters leaving the estuary. As much as possible, groups attempted to sample on a similar tide regime each month. Each year, their efforts in coordinating sampling times have improved. Stations are visited on a rising tide that continues to reach its fullest and starts to drop during the four to five hours it generally takes to complete all six CAMP stations. Since the groups try to start out sampling each morning, this regime sometimes has to be adjusted. There have been instances where sampling is carried out over two days. There are other circumstances, such as new and full moon tides that make the station unsatisfactory for a visit. Drastic weather changes during the day can also make sampling unsafe or just plain uncomfortable.

Table 4. Average monthly salinity (ppt ± S.D.) per location for the 2006 season (n = 6). (NA = not available)

	Salinity (ppt) ± S.D.				
N.B.	**May**	**June**	**July**	**Aug**	**Sept**
Caraquet	21.9 ± 1.1	24.7 ± 1.1	26.9 ± 1.0	28.8 ± 0.8	27.8 ± 1.0
Lamèque	27.1 ± 0.9	25.2 ± 0.3	25.6 ± 1.4	28.2 ± 0.9	28.6 ± 0.8
Shippagan	26.6 ± 2.2	25.2 ± 0.8	27.1 ± 0.8	29.0 ± 0.4	28.9 ± 0.2
Tracadie	24.0 ± 2.0	24.9 ± 2.8	23.5 ± 3.0	25.5 ± 1.5	25.3 ± 2.7
Tabusintac	19.2 ± 3.5	13.8 ± 4.3	19.1 ± 3.3	21.0 ± 2.5	22.6 ± 2.3
Miramichi	10.3 ± 6.8	8.0 ± 6.4	13.0 ± 6.4	17.2 ± 5.6	17.2 ± 5.0
St Louis	8.0 ± 2.3	6.2 ± 1.9	16.3 ± 4.1	14.5 ± 3.2	17.0 ± 1.7
Richibucto	22.3 ± 2.3	14.3 ± 3.2	25.1 ± 1.6	23.3 ± 1.6	23.1 ± 2.8
Bouctouche	19.5 ± 3.6	23.3 ± 1.7	24.4 ± 1.0	21.1 ± 1.5	23.5 ± 0.9
Cocagne	NA	24.6 ± 1.6	26.1 ± 1.1	24.1 ± 1.6	26.6 ± 0.5
Shediac	23.7 ± 1.3	27.0 ± 4.7	19.9 ± 6.1	24.0 ± 1.6	22.3 ± 7.5
Jourimain	27.5 ± 0.7	NA	27.3 ± 0.5	26.9 ± 1.2	27.5 ± 0.3
N.S.					
R. Phil-Pugwash	26.6 ± 1.2	22.5 ± 2.9	23.3 ± 4.7	27.4 ± 0.9	25.4 ± 2.5
Antigonish	18.4 ± 6.8	17.9 ± 5.2	23.5 ± 5.3	25.4 ± 3.3	26.7 ± 1.7
Mabou	20.2 ± 7.9	24.4 ± 2.4	25.7 ± 0.5	24.1 ± 2.4	27.6 ± 0.3
Pictou	20.9 ± 6.4	17.5 ± 8.0	24.1 ± 3.1	27.2 ± 1.2	24.2 ± 4.5
P.E.I.					
Mill River	22.3 ± 0.8	22.5 ± 1.0	22.7 ± 1.2	22.4 ± 1.2	23.1 ± 0.5
Trout River	22.4 ± 2.1	22.3 ± 3.6	23.7 ± 2.0	23.1 ± 1.6	21.4 ± 5.4
Basin Head	28.2 ± 0.5	26.7 ± 0.9	26.7 ± 0.7	26.7 ± 0.5	27.4 ± 1.0
Pinette	NA	NA	NA	26.8 ± 1.2	26.3 ± 0.7
Murray	NA	NA	26.0 ± 1.7	26.9 ± 1.6	27.5 ± 0.6
Mont.-Bruden	NA	25.2 ± 1.0	26.9 ± 0.3	27.5 ± 0.4	26.5 ± 2.0

In New Brunswick, lower salinities are noted for St. Louis de Kent and Miramichi estuaries because they were sampled further up the estuary than other sites in NB. These two longer estuaries have lower salinities in the upper sites and higher salinities at the mouth. The stations located farther up river might be subject to changes in future sampling and moved downriver where the salinity range is comparable to the other sites. In most, but not all cases, the salinities in May were slightly higher than in June, similar to the July values and then lower than the August and September values. This pattern did not hold true for Caraquet, Bouctouche and Shediac. In Nova Scotia, Antigonish had the lowest salinity value in May and increased throughout the season to its highest value in September. Pictou had a low reading in June (with the highest standard deviation) but was stable during the other months. There were no outstanding abnormalities at the other two locations. In Prince Edward Island, the three baseline locations had consistent salinity values for all five months. In all three provinces, the majority of salinity averages were between 22 and 27 ppt.

Dissolved oxygen values (Table 5) were taken at each station after completion of the beach sampling. The average of the six stations was used to provide a value for that sampling location for that month and summarized in the table below.

Table 5. Average monthly dissolved oxygen (mg/l ± S.D.) per location for the 2006 season (n = 6). (NA = not available) (* four or ** five stations measured)

	Dissolved Oxygen (mg/l) ± S.D.				
N.B.	**May**	**June**	**July**	**Aug**	**Sept**
Caraquet	7.7 ± 1.0	6.2 ± 1.1	7.3 ± 2.7	7.1 ± 0.6	9.3 ± 0.8
Lamèque	10.1 ± 0.9	7.3 ± 1.3	0.8 ± 0.3*	8.2 ± 0.9	6.7 ± 1.2
Shippagan	11.6 ± 1.9	8.4 ± 1.1	6.9 ± 1.4	9.2 ± 0.8	8.9 ± 0.8
Tracadie	10.4 ± 0.9	8.7 ± 2.9	9.6 ± 3.0	8.2 ± 2.4	9.7 ± 1.3
Tabusintac	8.4 ± 0.2	7.3 ± 1.2	7.6 ± 0.9	5.9 [illegible] 5	9.4 ± 0.7
Miramichi	10.0 ± 2.0*	8.5 ± 0.8	6.7 ± 1.2	7.0 ± [illegible].9**	7.5 ± 0.6
St Louis	8.7 ± 0.4	7.3 ± 0.4	7.1 ± 1.5	7.1 ± 0.4	6.3 ± 0.6
Richibucto	9.1 ± 0.4	8.4 ± 1.5	7.0 ± 0.9	8.3 ± 1.0	7.6 ± 0.9
Bouctouche	5.0 ± 0.1	7.2 ± 0.8	6.3 ± 0.5	7.7 ± 0.9	7.4 ± 0.6
Cocagne	NA	9.5 ± 5.4	5.8 ± 0.5	8.2 ± 0.6	6.6 ± 0.9
Shediac	6.1 ± 0.8	5.5 ± 0.2	6.3 ± 0.9	7.2 ± 0.7	10.8 ± 7.8
Jourimain	5.6 ± 0.3	NA	5.8 ± 0.3	6.7 ± 0.4	6.5 ± 0.3
N.S.					
R. Phil-Pugwash	7.2 ± 2.1	7.2 ± 0.6	7.7 ± 0.5	6.6 ± 0.3	8.5 ± 0.5
Antigonish	9.3 ± 0.4	8.8 ± 0.7	7.1 ± 1.1	8.7 ± 1.8	7.8 ± 0.7
Mabou	9.0 ± 0.5	6.6 ± 1.5	7.8 ± 1.2	8.9 ± 1.1	7.5 ± 0.7
Pictou	7.8 ± 1.8	9.2 ± 1.5	7.5 ± 1.6	8.4 ± 0.9	7.5 ± 0.7
P.E.I.					
Mill River	7.0 ± 0.6	7.4 ± 0.9	5.6 ± 0.9	6.7 ± 1.0	8.3 ± 0.9
Trout River	4.3 ± 0.4	11.5 ± 4.4	5.2 ± 1.1	7.7 ± 0.1	8.8 ± 1.5
Basin Head	7.3 ± 0.9	7.9 ± 1.1	6.8 ± 0.9	8.4 ± 1.2	8.7 ± 0.6
Pinette	NA	NA	NA	7.3 ± 1.3	10.2 ± 1.3
Murray	NA	NA	8.6 ± 1.1	9.7 ± 2.0	9.0 ± 0.2
Mont.-Bruden	NA	NA	7.9 ± 1.1	8.4 ± 0.7	8.4 ± 0.7

Dissolved oxygen values (Table 5) were generally highest in the spring sampling and had decreased by the June sampling. This pattern exists for all New Brunswick locations except Bouctouche. After June, dissolved oxygen values went up and down with no perceptible pattern. Overall, most DO values remain below 10 mg/l. One very low reading in Lamèque in July remains unexplained (possible extreme [illegible]utrophication), though only four readings were available for the average. Two of these four stations were closest to the fish processing plant; the other two were located on the innermost part of Lamèque Bay. In Nova Scotia, spring values were higher in May than June except in Pictou. Otherwise, no major

fluctuations were evident for the remainder of the sampling regime. In Prince Edward Island, May values for dissolved oxygen were low and then increased in June at all baseline locations. These same readings dropped in July and then increased for the next two months to levels that were higher in September than May. Trout River had the lowest value in May of all locations.

3.5 Nutrient Analysis

In September, each group was given 12 number coded 30 ml bottles to collect a water sample and a replicate at each site or station in their estuary or coastal location. The protocol for collection is outlined in Appendix 2 in this report. The groups were given a small cooler bag with an ice pack to hold the samples in until they returned to a location that had a freezer. These frozen samples were returned to DFO where the season's sample was sent to the Bedford Institute of Oceanography for nutrient analysis. For each sample the total micromoles of silicate, phosphate, nitrite (NO_2), nitrate ($NO_2 + NO_3$) and ammonia (NH_3) were determined. From the raw data the average was calculated for each baseline location.

Table 6. Average nutrient content of five listed compounds (µM ± S.D.) per location for the 2006 season (n = 12). (µM = µg atom /L)

	Silicate	Phosphate	Nitrite	Nitrate	Ammonia
	µM ± S.D.	µM ± S.D.	µM ± S.D.	µM ± S.D.	µM ± S.D.
N.B.					
Caraquet	4.12 ± 0.57	0.37 ± 0.04	0.17 ± 0.00	0.71 ± 0.04	0.87 ± 0.11
Lamèque	3.37 ± 0.85	0.41 ± 0.10	0.19 ± 0.04	0.41 ± 0.15	4.45 ± 1.58
Shippagan	1.08 ± 0.32	0.35 ± 0.07	0.12 ± 0.03	0.39 ± 0.12	1.40 ± 0.37
Tracadie	4.29 ± 0.96	0.55 ± 0.06	0.05 ± 0.01	0.13 ± 0.04	1.60 ± 0.31
Tabusintac	16.07 ± 3.04	0.67 ± 0.04	0.15 ± 0.01	0.88 ± 0.13	1.70 ± 0.61
Miramichi	25.11 ± 6.70	0.56 ± 0.04	0.17 ± 0.03	0.54 ± 0.14	3.31 ± 0.46
St Louis	13.54 ± 2.35	0.74 ± 0.09	0.19 ± 0.02	1.31 ± 0.48	1.73 ± 0.35
Richibucto	6.28 ± 1.83	0.36 ± 0.05	0.09 ± 0.01	0.47 ± 0.39	1.13 ± 0.14
Bouctouche	5.53 ± 0.53	1.05 ± 0.05	0.18 ± 0.01	0.86 ± 0.14	1.78 ± 0.17
Cocagne	1.82 ± 0.35	0.53 ± 0.01	0.21 ± 0.04	0.91 ± 0.10	5.80 ± 2.61
Shediac	3.05 ± 1.80	2.18 ± 1.32	0.21 ± 0.05	1.08 ± 0.39	34.32 ± 30.09
Jourimain	0.54 ± 0.04	0.45 ± 0.05	0.16 ± 0.01	0.71 ± 0.03	0.60 ± 0.14
N.S.					
R. Phil-Pugwash	6.08 ± 1.74	0.62 ± 0.13	0.23 ± 0.04	0.91 ± 0.31	2.69 ± 0.21
Antigonish	2.51 ± 0.46	0.51 ± 0.12	0.12 ± 0.02	0.09 ± 0.07	2.84 ± 0.55
Mabou	22.66 ± 3.24	0.18 ± 0.02	0.20 ± 0.01	2.30 ± 0.48	2.83 ± 0.44
Pictou	7.30 ± 2.20	1.96 ± 1.09	0.52 ± 0.29	1.89 ± 1.14	35.22 ± 32.71
P.E.I.					
Mill River	24.16 ± 1.93	0.38 ± 0.03	0.57 ± 0.07	101.33 ± 12.63	10.50 ± 1.79
Trout River	8.97 ± 2.74	0.54 ± 0.10	0.30 ± 0.07	10.84 ± 3.64	4.02 ± 1.93
Basin Head	3.02 ± 0.31	0.26 ± 0.02	0.12 ± 0.01	1.86 ± 0.66	2.21 ± 0.29
Pinette	12.53 ± 3.56	1.54 ± 0.23	0.20 ± 0.02	0.72 ± 0.11	3.19 ± 0.44
Murray	6.87 ± 1.71	0.83 ± 0.05	0.15 ± 0.02	1.18 ± 0.84	1.21 ± 0.18
Mont.-Bruden	1.02 ± 0.14	0.46 ± 0.04	0.22 ± 0.06	1.00 ± 0.40	0.85 ± 0.05

4.0 DISCUSSION

4.1 Fish and Crustaceans

In northeastern NB; mummichog, shrimp species, silverside and threespine sticklebacks were the adundant species at all four locations (i.e. Caraquet, Lamèque, Shippagan and Tracadie). *Fundulus* species (mummichog and killifish) dominated the abundance numbers in Lamèque, Shippagan and Tracadie and shrimp species were most numerous in Caraquet.

In 2005, none of the stickleback species showed overall dominance in abundance values. In 2006 however, the threespine stickleback had the dominant abundance values for sticklebacks in all four locations. Ninespine sticklebacks were present in all locations but had the lowest abundance values. The other two frequently occurring stickleback species, fourspine and blackspotted, had values of abundance in between these two extremes.

Higher mean species richness was observed in three locations in May and in June in Shippagan. It would seem probable that this is the result of normal aggregative behaviour related to feeding and breeding. Also, certain species move into the estuaries after overwintering at sea (eg. Atlantic silverside; Conover and Murawski 1982). As the sampling season progresses, the populations of most small pelagics seem to disperse throughout the near shore habitat as their numbers generally decline. Analysis of three years of accumulated data for the CAMP program may provide some insight to this proposed population movement. This analysis is scheduled to be completed by summer 2008.

In central New Brunswick, two estuary NGOs (Tabusintac and Richibucto) joined with Miramichi and St. Louis de Kent in sampling the full five months so as to be considered full baseline locations. The most abundant fish species in all four locations was the Atlantic silverside. The numbers for crustacean species were highest in Miramichi and Richibucto.

As in 2005, the higher abundance totals for species collected in St. Louis probably reflects the differences in estuary site characteristics. More vegetation, thus more habitat for protection, characterizes most of the St. Louis sites. Compared to other locations where sand is the more dominant substrate, more vegetation can help substantiate the higher abundance totals in St. Louis. Also, salinity averages were lower in St. Louis than other estuaries. One innermost station was moved farther out in 2006. Moving sites to more saline water will also be examined for the Miramichi in 2007. This move is being suggested so that all Gulf estuaries will be as comparable as possible when we relate physical characteristics to the biological community structure. Unlike northern NB, the fourspine was the most abundant stickleback species in all central locations, except in Tabusintac (threespine numbers were greater) located in central NB. This follows northern trends as Tabusintac is closer to Tracadie than it is to Richibucto. Striped bass juveniles were most abundant in the "other" category in the Miramichi. Their population numbers were up from 2005 levels.

The month with the highest species richness values differed at each location in central NB. As in 2005, species richness was generally higher in central than in northern NB.

In southeastern NB; two sites, the Little Bouctouche and Cocagne did not maintain baseline status, though Cocagne did sample for four months. Bouctouche, Shediac and Cape Jourimain sampled for all five months. Silversides were the most abundant fish species at all four locations. Silversides were very abundant in one station in Shediac that was near a seafood

processing plant outflow pipe; silversides seem to prefer this nutrient rich environment. More information can be found in Theriault et al. (2006) regarding this phenomenon. The fourspine was the most abundant stickleback species as it was in central NB, except at Cape Jourimain where black spotted numbers were higher. This could be related to the fact that Cape Jourimain is more of an open coastal location, compared to most other locations where sampling takes place in upper parts of the estuary.

Mean species richness was only slightly higher in May and June than other months in southeastern NB. Overall comparison with other parts of the province put the southeast in-between the north and central as far as mean species richness is concerned.

In Nova Scotia, River Phillip and Pugwash again partnered to maintain baseline status. Pictou, Antigonish maintained baseline status primarily due to the continued involvement of biology students from St. Francis Xavier University. The Mabou group maintained their strong presence. Sand shrimp was the most abundant crustacean, and the most abundant species at all locations overall. For the fish, *Fundulus* species, especially mummichogs were second in abundance at all four locations. There is no obvious relation among abundance numbers for stickleback species in the four NS locations. Fourspine sticklebacks were third in abundance at all locations except Pictou where they ranked second. The invasive green crab was found in all Nova Scotia locations, though the individuals in River Philip were noted as possible rather than confirmed. Mabou had the greatest species richness as in 2005 and River Philip - Pugwash showed the lower numbers for species richness.

In Prince Edward Island, re-organization for the Southeast Environmental Association made it impossible for them to maintain baseline status. They did manage to sample for CAMP in the late summer and fall, as their results indicate. It is expected they will resume full sampling next year and regain baseline status. As such, their results will not be discussed with the three baseline sites. *Fundulus* species and sand shrimp were the dominant species at the baseline locations. Overall, population numbers were higher in Mill and Trout rivers than at Basin Head. The fourspine stickleback was most abundant in all three baseline locations. Ninespine sticklebacks were highest in number in Trout River perhaps because at least two of the stations were of relatively low salinity (Scott and Scott 1988). Green crab was found at all locations except Mill and Pinette rivers. The species richness was highest in May at most locations. Trout River maintained similar numbers throughout the season while the other two locations showed slight declines.

4.2 Macrophytes

The vegetation characteristics of individual stations at each location did not change much over the season, except for growth of the existing attached vegetation. The species of vegetation that were catalogued in May generally remained the same in September. An increase in vegetation was most noticeable where mud bottom substrates supported eelgrass populations. Sometimes the eelgrass dominated the outer edge of the sample. At higher tide samplings, this vegetation bed was often not swept by the beach seine. A continuing concern to NGO volunteers was the accumulation of unattached material in the beach seine at a sample site. Algae such as sea lettuce and eelgrass could hinder the effectiveness of collections by smothering fish before they could be counted and released unharmed. Since it was impossible to sweep a net through some sites in mid-summer, due to the large volumes of un-attached

algae, some station relocations were necessary. These stations were moved, but for as short a distance as possible, so a level of comparability was maintained. Many of the outer estuary or coastal sites were characterized by a dominant sandy/rocky substrate. Rockweed attached to rocks was the dominant species in these locations. Also present, especially later in the summer, were tufts of filamentous green algae. There were very few sites where no vegetation was present. In these instances a sandy bottom was the dominant substrate.

The methods used by the CAMP for quantifying submerged aquatic vegetation and substrates are qualitative and serve to describe the general state of vegetation at each site. General comparisons can then be made from year to year. Table 1 showed some changes from 2005. Vegetation differences from year to year do occur and these changes can be due to actual change in the vegetation profile, slight variation of the station location, recorder evaluation of the station or a combination of all of these factors. Over time an averaging of the results of the station will produce the best possible picture of the vegetation profile. As with vegetation descriptions, volunteers could record descriptions of substrate differently in that a mud site might change to a mud-sand site, or vice versa, depending on the stage of the tide at the time of sampling. To get a more accurate description of each site, a more labour intensive transect grid method could be used. At this point in time, the vegetation data determined by present CAMP methods has proven to be inadequate. In 2007, a different method of recording percentages will be used based on a graduated scale.

4.3 Substrate

The sediment samples collected in September 2006 were analyzed in early spring 2007. In New Brunswick, percent moisture content averaged 22.3% over all 12 locations with Bouctouche being the highest at 25%. These numbers are down about 3 percent from 2005. The sediments generally had higher organic content than recorded in 2005; the average of all sites was 5.4 % compared to 2.0% in 2005. One location, Shediac, recorded an average organic content above 13 percent. The average of the mean grain size was 0.47 mm. These differences illustrate the importance in having several years of data to get the best average picture of these various physical descriptors.

In Nova Scotia, Pictou had the highest total organic content at 3.4 % and total moisture content at 21.3 %. Antigonish had slightly lower values and samples were not available for the other two locations. Mean grain size was between 1.0 and 1.5 mm.

Organic content ranged from 0.5 to 4.1 percent in Prince Edward Island. Percent moisture averaged 26.1 for the six stations. The mean grain size was 0.28 mm for the six locations. There were no extremes in the data except Trout River which had more mud sites than other locations in the province.

One general observation is that mud bottoms with characteristic small mean grain size had higher percentages of both organic matter and moisture. The opposite patterns exist for sandy bottom locations.

4.4 Physical Measures

Three physical measures were taken as part of the CAMP collection protocol. These data provide a measure of monthly changes that occur at sample locations. The same pattern of cooler temperatures in the spring, warming as the summer progressed and cooling off in the fall appears normal. In some cases a drop in mid summer was probably due to abnormal weather, a cooling event or changes that might occur in circulation patterns as locally affected by wind. Data from the temperature profilers provide an overview of the changes in estuary temperature over the sampling season. Fewer loggers were retrieved in 2006 than in 2005. Alternate methods of attachment will be used in 2007. In New Brunswick, there was a slight drop in the weekly average in late June and late July. The other two provinces show no anomalies from a normal increase of water temperature with warming air temperatures in late spring and a gradual drop as it cools off in the fall.

In the upper estuary samples, salinity was lower as expected due to the large fresh water influence. There is monthly variation. The dominant pattern is that early months have lower salinities for most locations, probably due to run-off related to spring snow melt. Middle sites in most locations vary in salinity, and this probably can be attributed to the state of the tide. Incoming tides bring in higher salt water content as compared to the increase in fresh water outflow when the tide was receding. The outer stations had the higher salinities.

Dissolved oxygen preferences for permanent estuary/coastal shoreline species are not well documented. The general pattern for oxygen levels in the estuary was higher quantities in the spring that fluctuated in the summer and generally increased again in the fall. Processes that allow oxygen input in the water column include photosynthesis by plants and mixing from the air due to turbulence. In locations where there was more organic matter, such as near seafood processing plants, decomposition of organic matter could produce the lower oxygen levels recorded (Tchoukanova et al. 2003).

Future analysis will investigate any correlations among the physical factors and fish population dynamics.

4.5 Nutrient Analysis

A detailed breakdown of the preliminary trends of the five nutrient compounds is provided by Theriault and Courtenay 2008 (unpublished report). This analysis is for only one month (September) and thus provides a snapshot of nutrient content on the sampling day. It is proposed that the sampling will expand to once a month in 2007. Expansion of nutrient collections will allow a better comparison of nutrient levels each month with population abundance and diversity. The importance of this baseline information relates to conditions in the estuary, therefore providing another parameter to use to categorize the health of the estuaries.

Among the 22 sites sampled in 2006 some were considered relatively pristine. These include St-Louis de Kent, Tabusintac and Mabou, none of which have large industrial activities or large anthropogenic impacts in their watersheds. Other sites are considered less pristine and exhibit evidence of anthropogenic impacts such as seafood processing plants (Lamèque, Shippagan, Cocagne, Scoudouc), pulp and paper mills (Pictou, Miramichi), sewage treatment plants (Bouctouche) and agricultural runoffs (Mill River and Trout River).

5.0 CONCLUSION

The fundamental objective of the CAMP program continues to be the development and continuation of an outreach program for DFO oceans and habitat staff to liaise with and engage the coastal communities in learning more about their estuaries and bays. The initial goal of developing a monitoring program that is NGO friendly has been realized. Baseline data have been collected for three years from a wide range of estuaries and bays in the Gulf of St. Lawrence.

After three years of data collection, we have the minimum baseline information to test the hypothesis that animal assemblages can contribute to our knowledge about the health of these habitats. The next steps for CAMP are now in the hands of the DFO and their associated university collaborators. The baseline data resulting from community efforts will be used to test the hypothesis that the numbers and types of nearshore animals provide us with an indication of the overall health of these estuaries. For example, can the absence or presence or abundance of particular species reflect particular environmental problems? Is it overall species diversity that provides the best single metric for estuarine health? When these and related questions have been addressed and the resulting conclusions have been returned to the participating community groups and the public at large, CAMP will have fulfilled its immediate objectives. However, it is recognized that as the CAMP evolves, there is always room for additional refinement. As such, the commitment to consultation with all stakeholders will continue.

NGO's anticipate that the data they have gathered will be useful in developing an authoritative tool to help them monitor the health and condition of their estuary. Now that the three years necessary for a preliminary analysis have been secured, a subsequent report is planned that will compile and present the data collected to date. Subsequently, community groups will continue to monitor the health of their estuary/coastal shoreline using the CAMP. DFO will continue to supply necessary working materials and continue to assist with the training and coordination of the program. The community groups continue to be the supporting backbone that is essential to the success of the program.

The CAMP has already proven to be a popular method for gathering data for estuaries and coastal shorelines. From an initial group of four pilot estuaries in 2003, participation grew to 24 in 2004. Of the 24 involved in 2004, 15 achieved baseline status by completing the full five months of sampling (Weldon et al. 2005). In 2005, there were 22 locations sampled and, of these, 20 maintained baseline status (Weldon et al. 2007). Of the 22 locations sampled in 2006, 18 maintained baseline status. The continued involvement of community groups illustrates that collecting data is important to the stewardship activities of the groups. As a vehicle for public education, CAMP has continued to have a positive impact. More than 80 individuals, including high school and university students, and interested members of the general public from teens to retirees were trained in the rudiments of fish and invertebrate identification and the basics of formal data collection for environment assessment. The involvement of non-professionals in CAMP activities has thus been a source of important public education and outreach on the part of DFO.

Besides a commitment to quality data recording, the community groups realize they have

only had to contribute resources for one day a month to acquire these data. The integrated approach provided by the University partners, DFO and certain funding agencies has helped guide the development of the CAMP to a direction that will maximize output goals from minimal input.

There is an expectation that more specialized science could easily be developed from the outcomes of the present CAMP data. As the Risk Analysis Model of watershed issues becomes more widely used, CAMP protocols and gathered information will become a key component in the overall management of a watershed.

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This program was originally developed through the Oceans and Habitat Division, Oceans and Science Branch (OSB), Gulf Region DFO. Gulf Region NGO's remain onboard with tremendous enthusiasm for volunteers that oversee ecological programs across the region. Summer students, both employed and volunteering were an invaluable resource for data collection. Some funding for student salaries came from Interdisciplinary Studies in Aquatic Resources at St. Francis Xavier University, and grants to Dr. David Garbary from the Natural Sciences and Engineering Research Council of Canada. Other groups used portions of Environmental Trust funds to free up resources for the one day a month necessary to maintain the program.

After the initial set-up of the pilot stage by several of the authors, the continued support of all stakeholders and continued consultation throughout the 2006 sampling season ensured that the program maintained strong links to the original concept.

REFERENCES

Canada's Ocean Strategy: Our Oceans, Our Future. Dept. of Fisheries and Oceans Ottawa: Oceans Directorate, Fisheries and Oceans Canada, c2002, 2002 vi, 30pp. http://www.cos-soc.gc.ca/dir/cos-soc_e.asp

Canada's Stewardship Agenda. 2003 http://www.dfo-mpo.gc.ca/canwaters-eauxcan/getinvolved-prendrepart/brochure/pdf/brochure_e.pdf

Conover, D. O. and S. A. Murawski. 1982. Offshore winter migration of the Atlantic silverside, *Menidia menidia*. Fisheries Bulletin 80:145-150.

Hansen, A.R. (ed.) 2004. Status and Conservation of Eelgrass (*Zostera marina*) in Eastern Canada. Canadian Wildlife Service, Atlantic Region, Technical Report Series No.412. 40 p.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6:21-27

Methven, D.A. and D.C. Schneider. 1998. Gear-dependent patterns of variation in catch of juvenile Atlantic cod (*Gadus morhua*) in coastal habitats. Canadian Journal of Fisheries and Aquatic Sciences 55: 1430-1442

Scott, W. B. & M. G. Scott. 1988. Atlantic Fishes of Canada. *Canadian Bulletin of Fisheries and Aquatic Sciences* 219:731pp

Thériault, M-H., Courtenay, S.C., Godin, C. and Ritchie, W. 2006. Evaluation of the Community Aquatic Monitoring Program (CAMP) to assess the health of four coastal areas within the southern Gulf of St. Lawrence with special reference to the impacts of effluent from seafood processing plants. Can. Tech. Rep. Fish Aquat. Sci. 2649. 60p.

Thériault, M-H. and Courtenay, S.C., 2008. Results for the 2006 Nutrient Analyses for the Community Aquatic Monitoring Program (unpublished report)

Tchoukanova N., M. Gonzalez, and S. Poirier. 2003. Best Management Practices: Marine Products Processing. Fisheries and Marine Products Division of the Coastal Zones Research Institute Inc., Shippagan, New Brunswick, Canada. 38p.

Weldon, J., Garbary, D., Ritchie, W., Courtenay, S., Godin, C., Thériault, M-H., Boudreau, M. and Lapenna, A. 2005. Community Aquatic Monitoring Program Results for New Brunswick, Prince Edward Island and Nova Scotia - 2004 Overview. Can. Tech. Rep. Fish. Aquat. Sci. 2624. 53 p.

Weldon, J., Courtenay, S. and Garbary, D. 2007. The Community Aquatic Monitoring Program (CAMP) for measuring Marine Environmental health in Coastal Waters of the southern Gulf of St. Lawrence: 2005 Overview. Can. Tech. Rep. Fish. Aquat. Sci. 2708: vii + 47 p.

Whitfield, A.K. and Elliot, M. 2002. Fishes as indicators of environmental and ecological changes within estuaries: a review of progress and some suggestions for the future. Journal of Fish biology 61 (Supplement A): 229-250

Appendix 1. List of Species Collected during the CAMP 2006

fish

alewife (gaspereau) (*Alosa sp.*)
American sand lance (*Ammodytes hexapterus*)
Atlantic silverside (*Menidia menidia*)
Atlantic tomcod (*Microgadus tomcod*)
banded killifish (*Fundulus diaphanus*)
black spotted stickleback (*Gasterosteus wheatlandi*)
blueback herring (*Alosa aestivalis*)
brook (speckled) trout (*Salvelinus fontinalis*)
cunner (*Tautogolabrus adspersus*)
fourspine stickleback (*Apeltes quadracus*)
ninespine stickleback (*Pungitius pungitius*)
northern pipefish (*Syngnathus fuscus*)
mummichog (*Fundulus heteroclitus*)
rainbow smelt (*Osmerus mordax*)
rock gunnel (*Pholis gunnellus*)
shorthorn sculpin (*Myoxocephalus scorpius*)
silver rockling (*Gaidropsarus argentatus*)
smooth flounder (*Pleuronectes putnami*)
striped bass (*Morone saxatilis*)
threespine stickleback (*Gasterosteus aculeatus*)
white perch (*Morone americanus*)
windowpane flounder (*Scophthalmus aquosus*)
winter flounder (*Pseudopleuronectes americanus*)
winter skate (*Raja ocellata*)
Atlantic salmon parr (*Salmo salar*)
Atlantic mackerel (*Scomber scombus*)*
Clubbed tunicate (*Styela clava*)*
Violet tunicate (*Betrylloides violaceus*)*
Vase tunicate (*Ciona intestinalis*)*

crustaceans

grass shrimp
(*Palaemonetes vulgaris*)
green crab
(*Carcinus maenas*)
lady crab
(*Ovalipes ocellatus*)
mud crabs
(*Xanthidae sp.*)
rock crab
(*Cancer irroratus*)
sand shrimp
(*Crangon septemspinosa*)

* new additions 2006

Appendix 2 Instructions for Collecting Water samples for Nutrient Analysis

CAMP Nutrient Sampling:

1- Walk out to a depth of approximately 3 feet and take the water sample in the middle of the water column, at about 1.5 feet. Avoid letting the bottle touch the bottom of the sea floor as this may contribute to unwanted sediment getting in. These bottles are sterilised, please don't get any dirty fingers, water, etc in the bottles or on cap, just sample water.

2- Always wear gloves (included with the bottles) to avoid contamination of nutrient samples and do not smoke near the samples!! Take 2 water samples for each station. Rinse the 2 small Nalgene® bottles provided with water 3 times, then, fill bottles to just under the shoulders of the bottles (DO NOT OVERFILL). Place the lid on the bottle without touching the threads to avoid contamination. Both bottles for each station are labeled with the same sticker numbers. There should only be one ID sticker number per duplicate set. Indicate which station corresponds to the number on the bottle in the table below. The sticky numbers are already included in the table. Do not write anything else on these bottles.

3- Samples should be placed upright in a cooler with ice and frozen UPRIGHT as soon as possible. Samples should not be thawed once frozen until they are analysed.

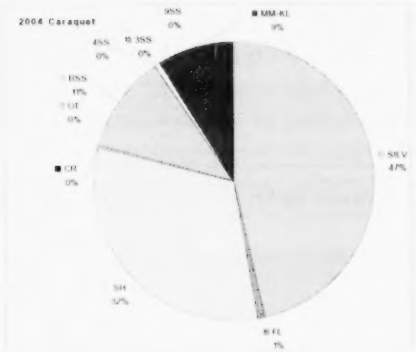
Please write the station number (1 to 6) which corresponds to the label on the bottles

CAMP site: **Province**: **Date collected**:

Label #	**Station # which corresponds to label on bottle**
1-	
2 -	
3 -	
4 -	
5 -	
6 -	

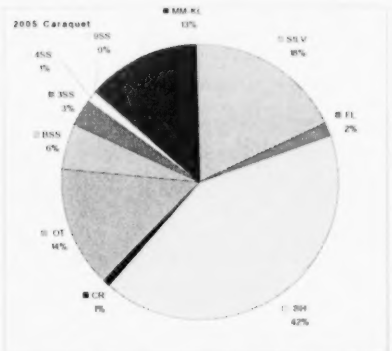
Please return this page with the samples. Thank you!

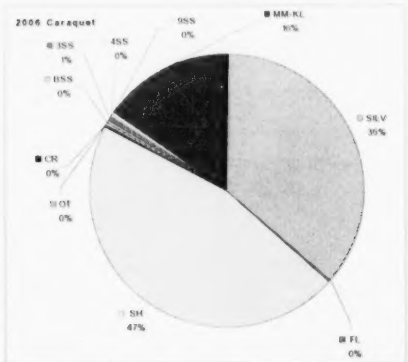
Appendix 3. Map of each Estuary/Coastal Shoreline Location Showing Sampling Sites plus three (if available) Pie Charts Summarizing the Season Total Percentages of the Most Abundant Species for 2004, 2005 and 2006 Sampling Seasons.

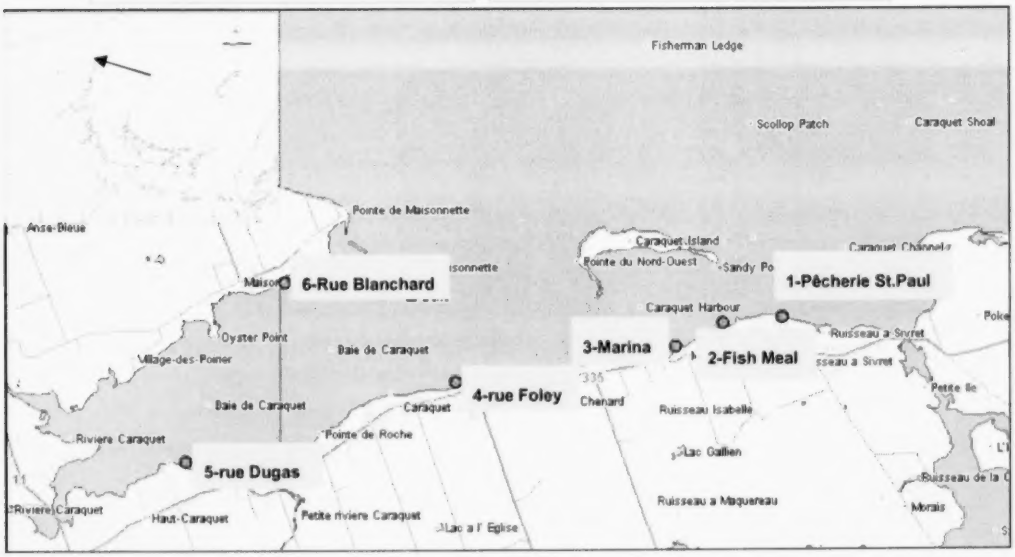


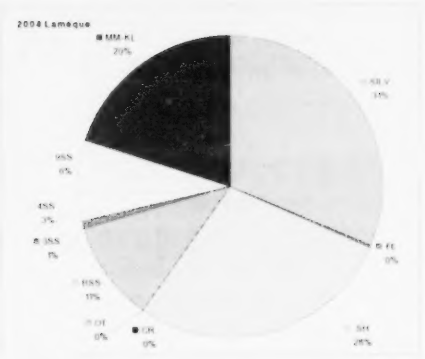
Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
3 Spine Stickleback (3SS)	Flounder Species (FL)
4 Spine Stickleback (4SS)	Shrimp Species (SH)
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

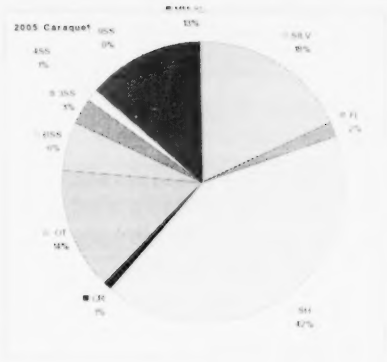
New Brunswick / Caraquet

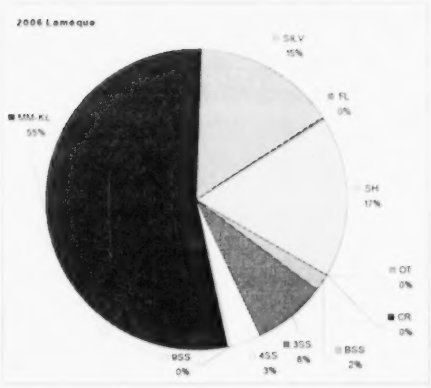












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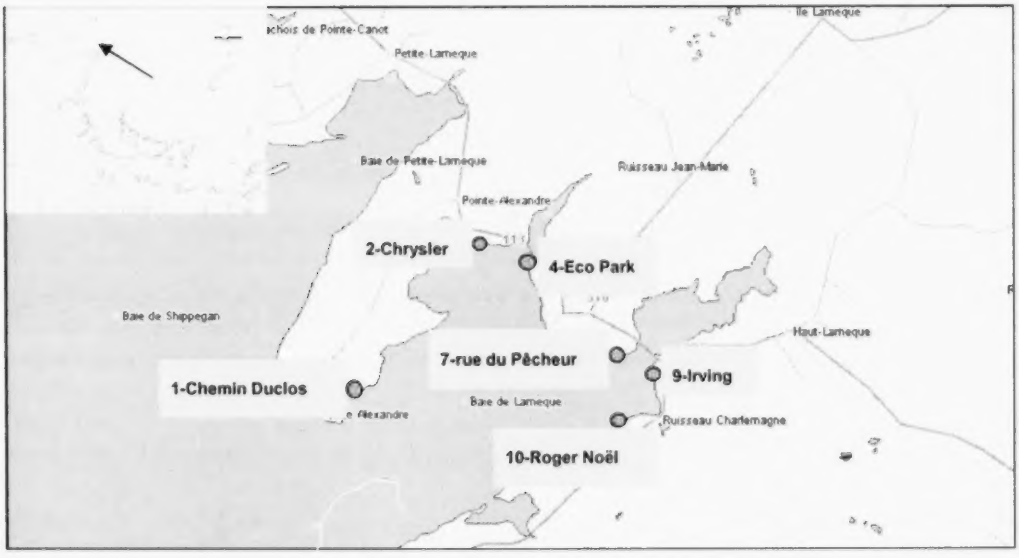
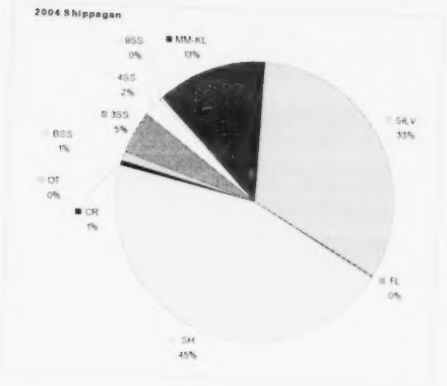
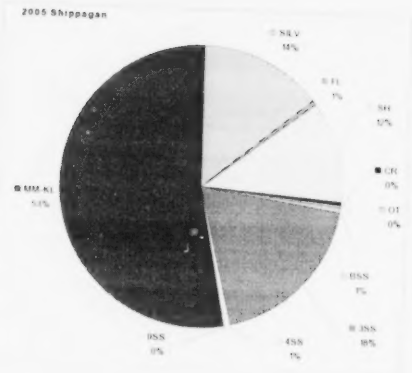
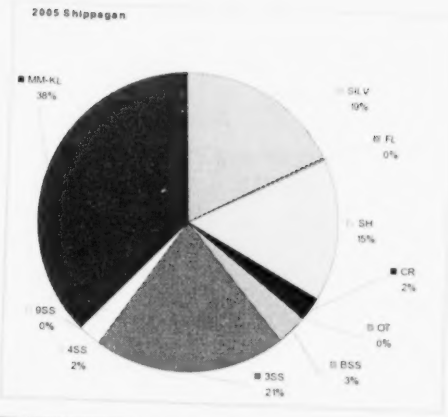
Mummichog/Killifish (MM-KL)	Other Species (OT)

New Brunswick / Lamèque









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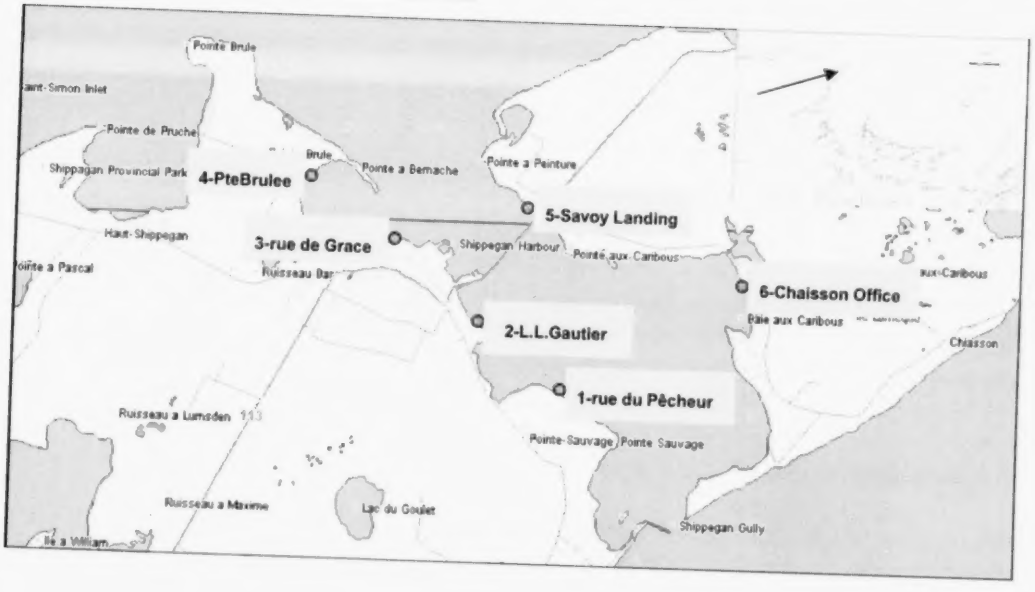
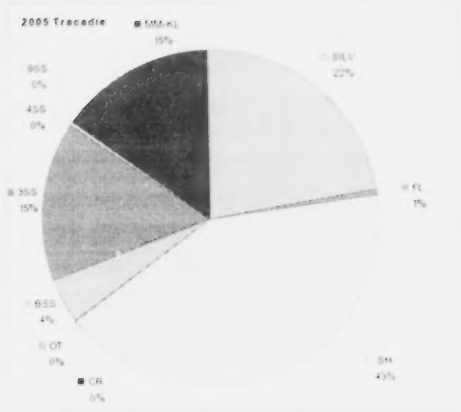
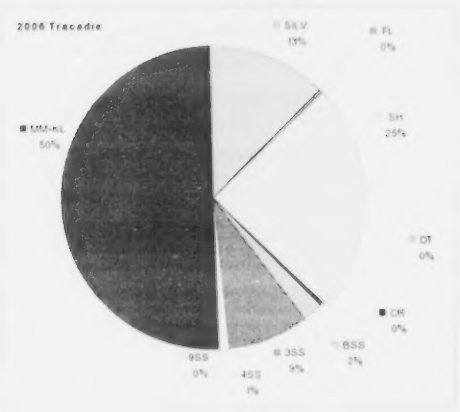
New Brunswick / Shippagan







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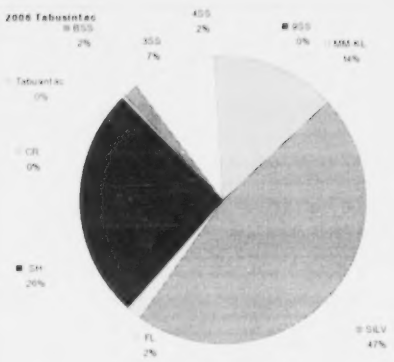
New Brunswick / Tracadie



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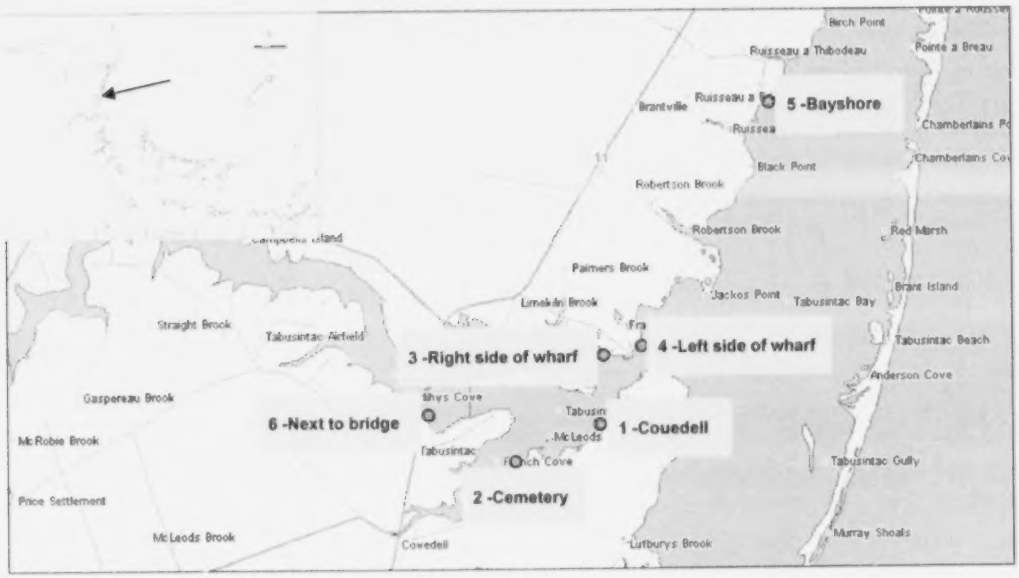
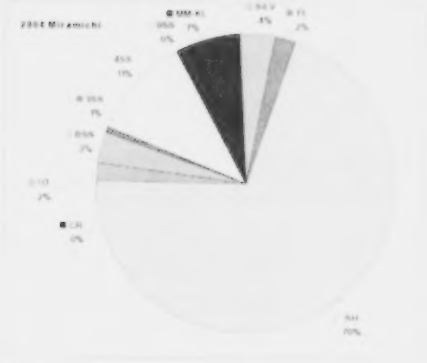
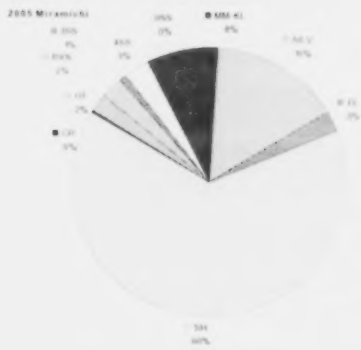
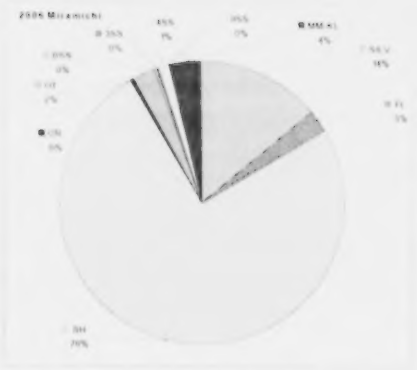
New Brunswick / Tabusintac









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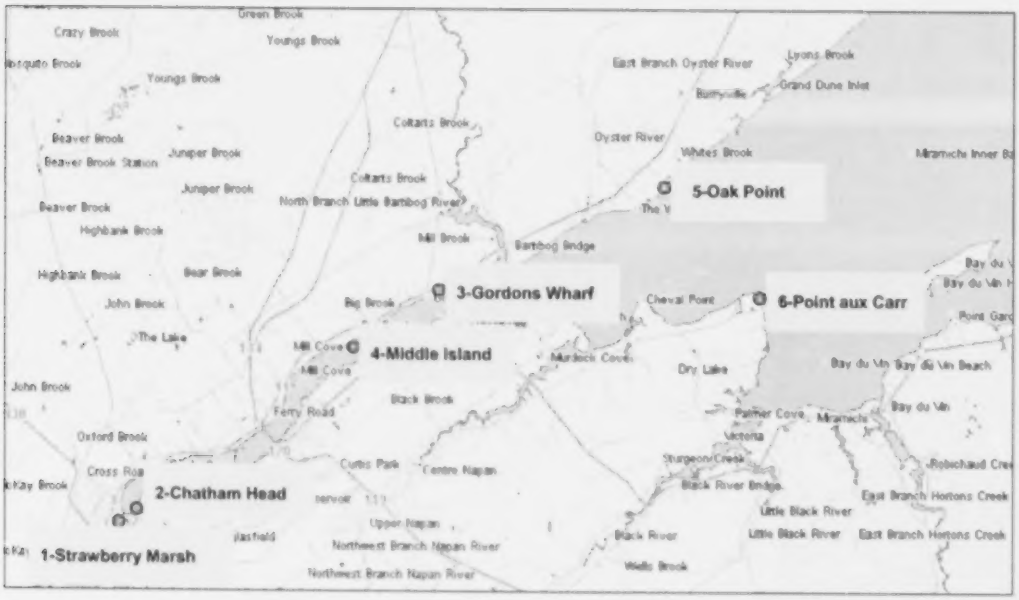
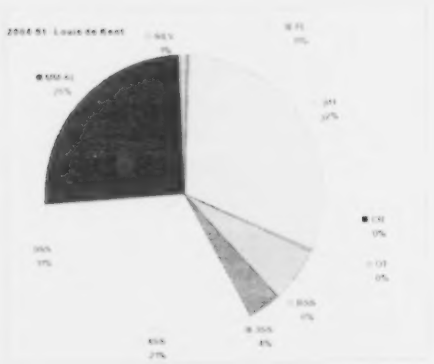
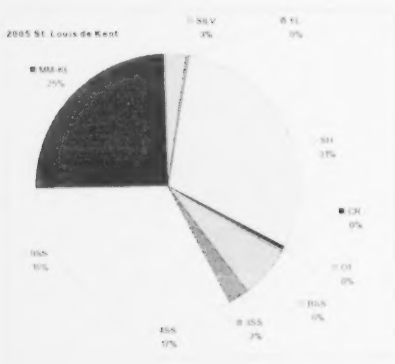
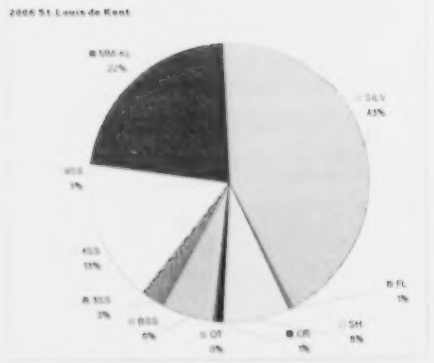
New Brunswick / Miramichi









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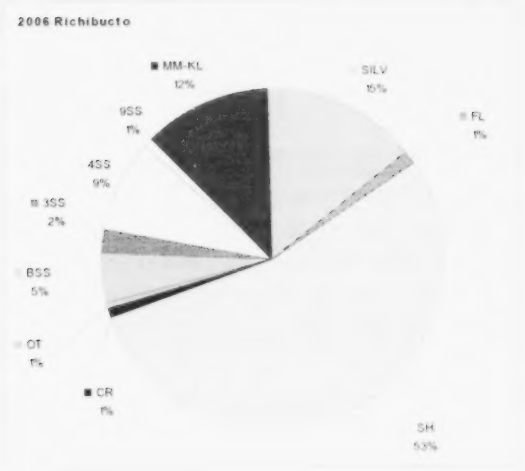
New Brunswick / St. Louis de Kent



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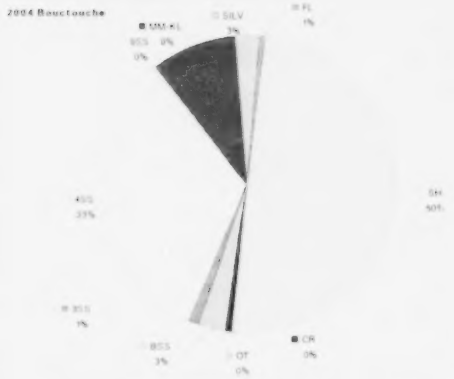
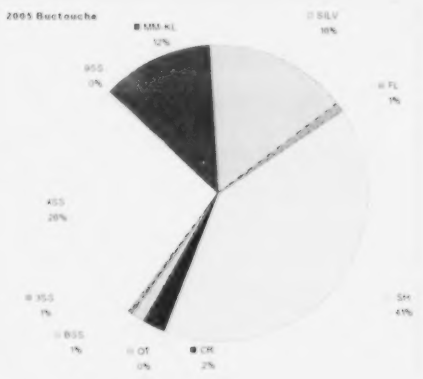
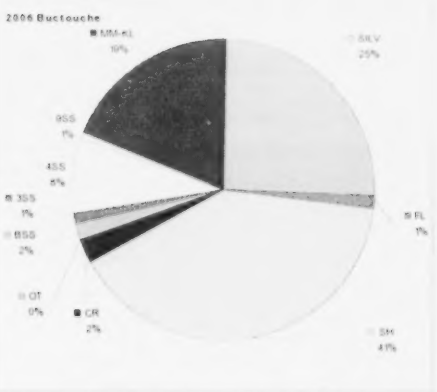
New Brunswick / Richibucto







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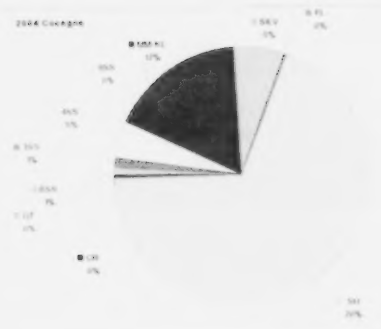
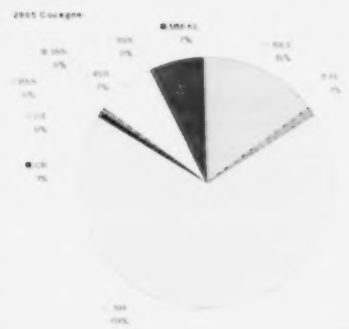
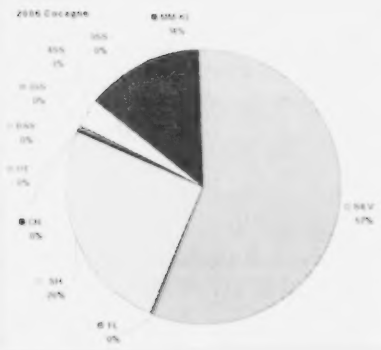
New Brunswick / Bouctouche







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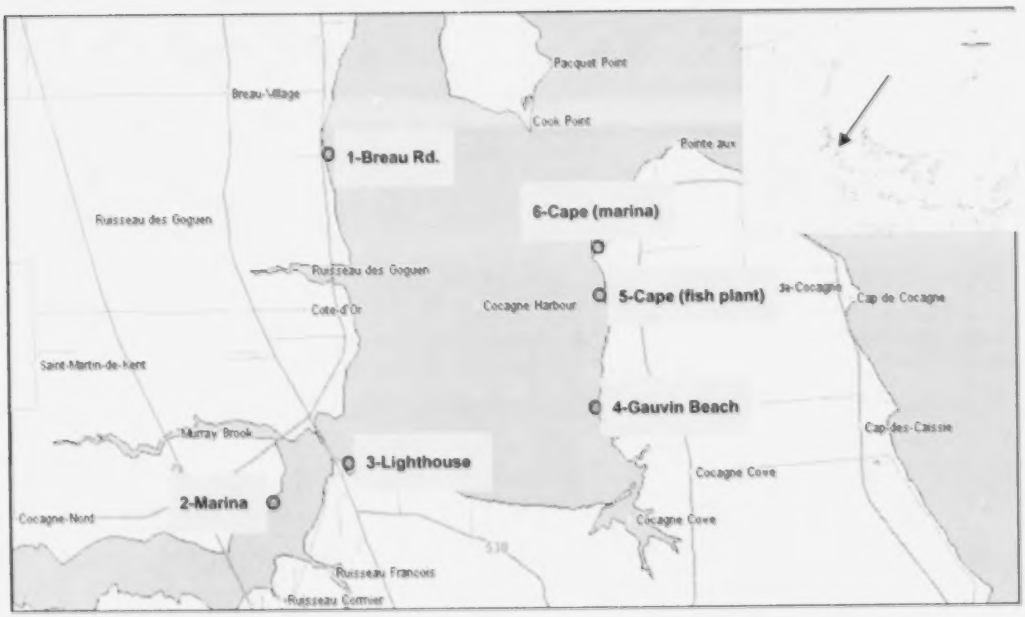
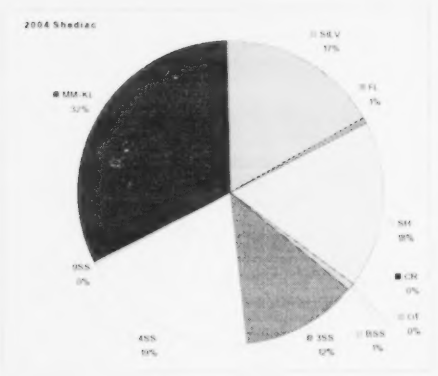
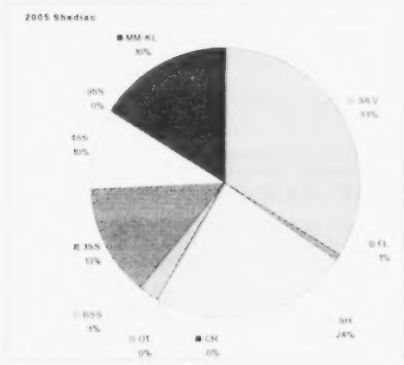
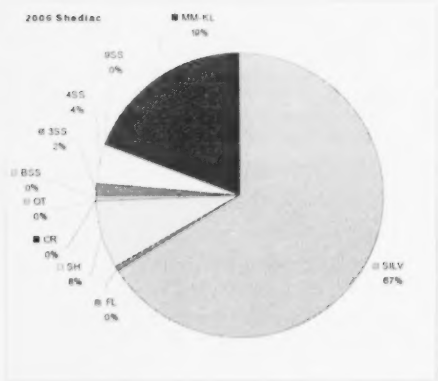
New Brunswick / Cocagne*

* represents 4 months data









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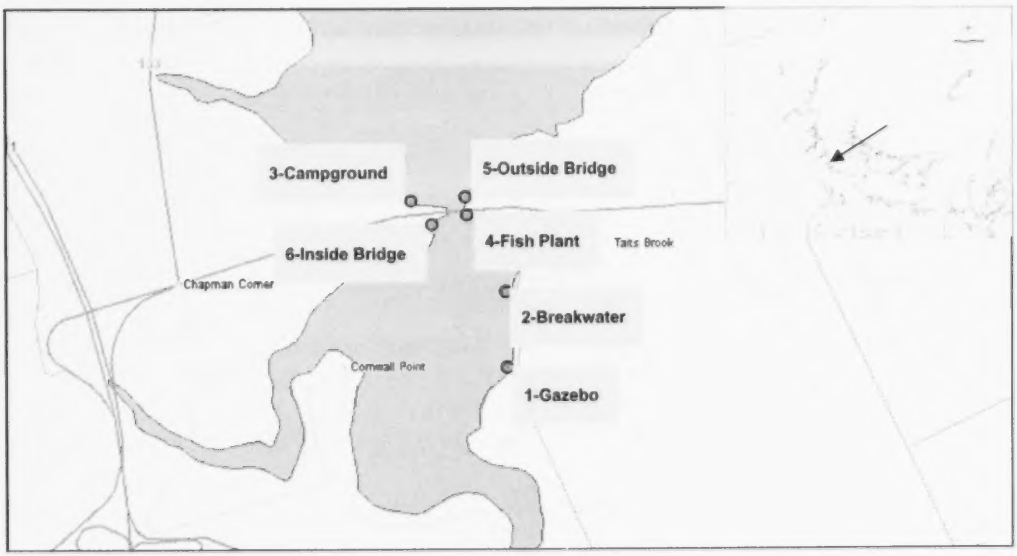
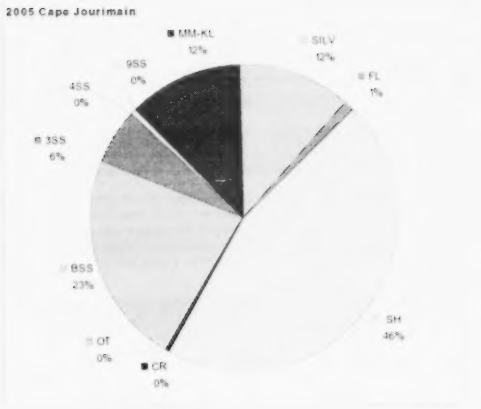
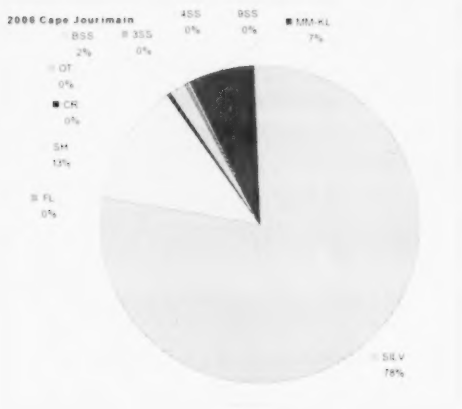
New Brunswick / Shediac

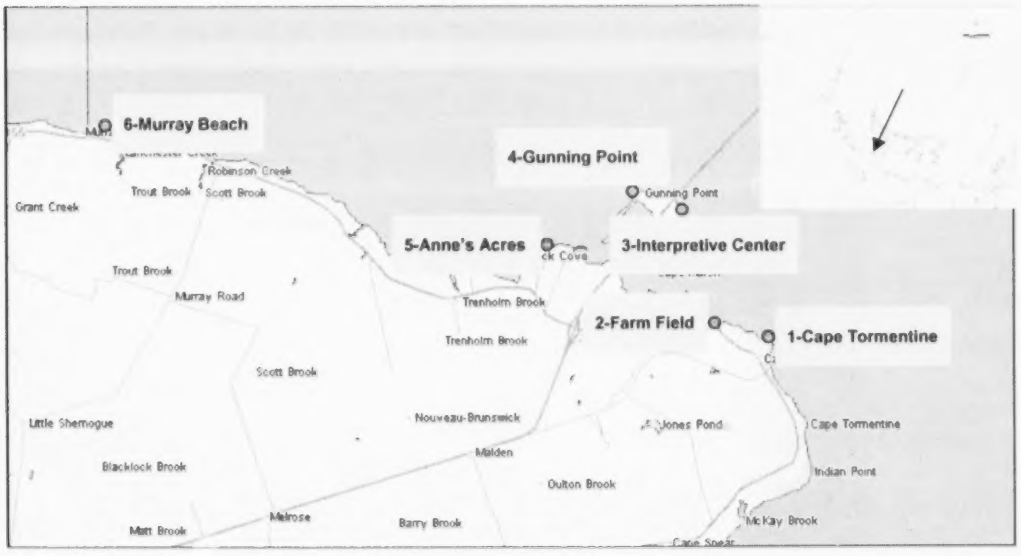


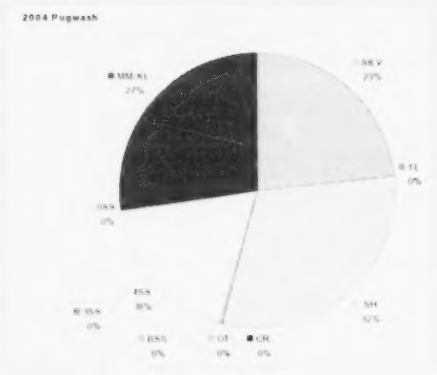


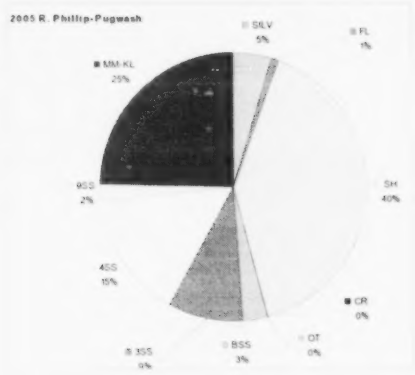


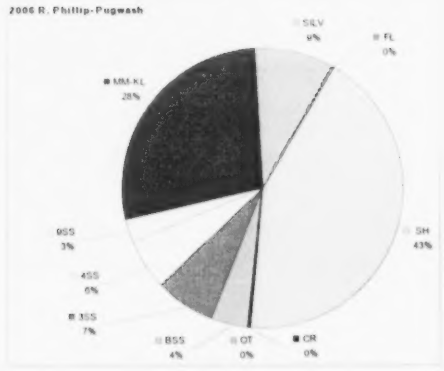
Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
3 Spine Stickleback (3SS)	Flounder Species (FL)
4 Spine Stickleback (4SS)	Shrimp Species (SH)
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

New Brunswick / Cape Jourimain



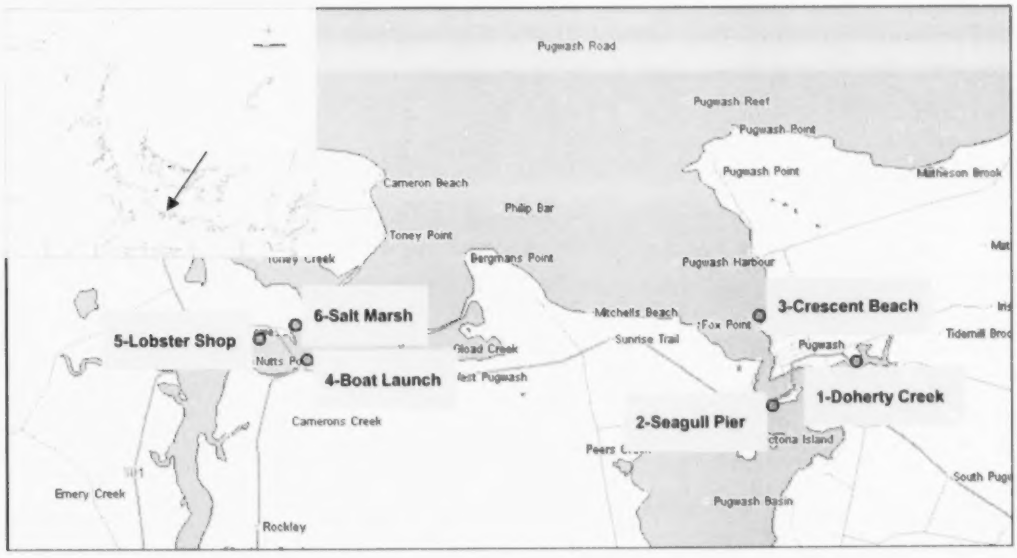


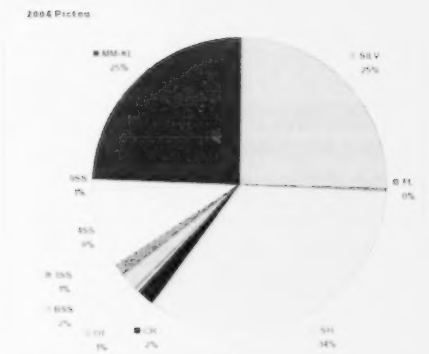


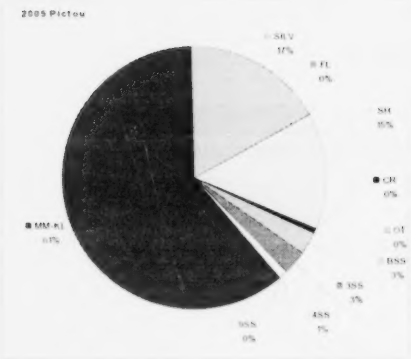


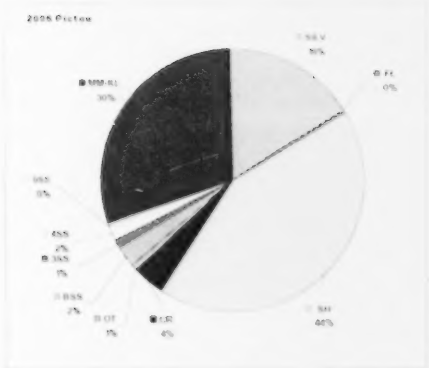
Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
3 Spine Stickleback (3SS)	Flounder Species (FL)
4 Spine Stickleback (4SS)	Shrimp Species (SH)
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Nova Scotia / River Phillip - Pugwash









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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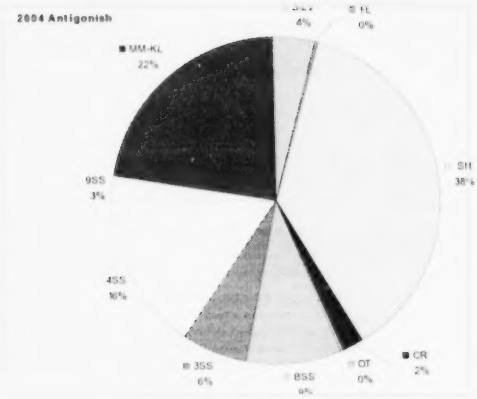
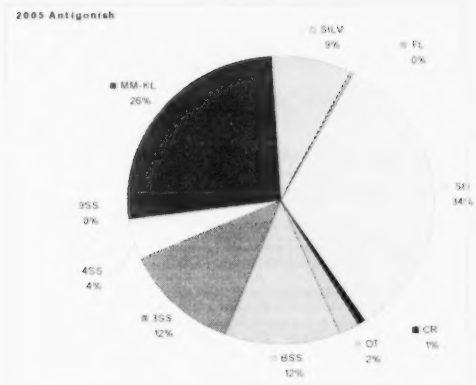
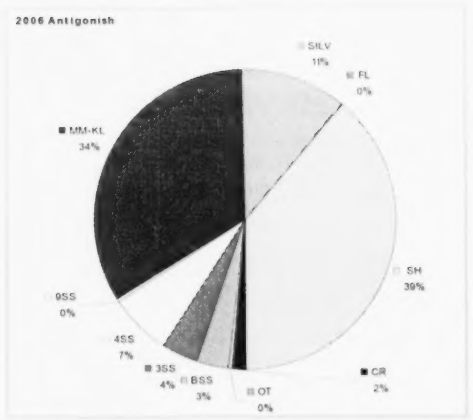
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Nova Scotia / Pictou







Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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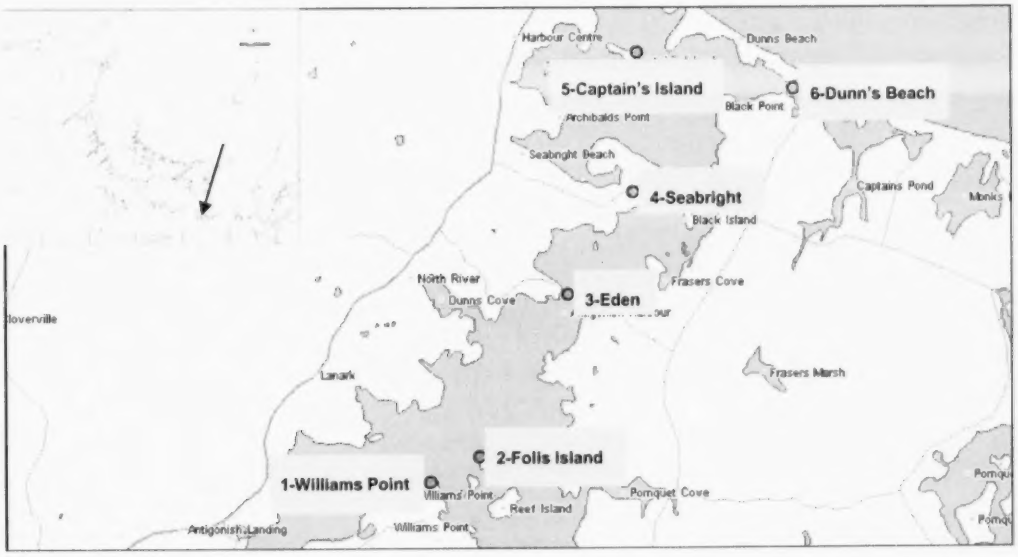
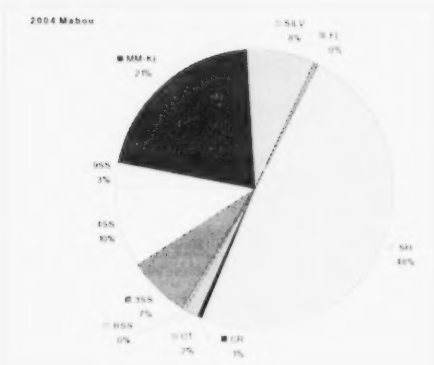
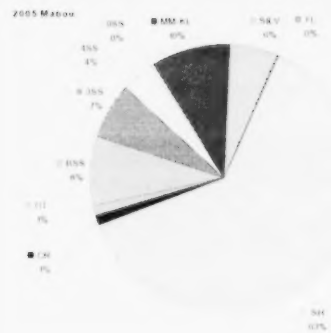
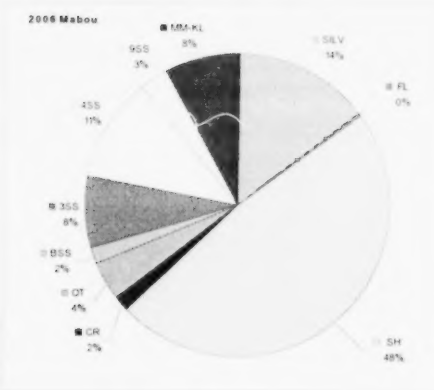
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Nova Scotia / Antigonish









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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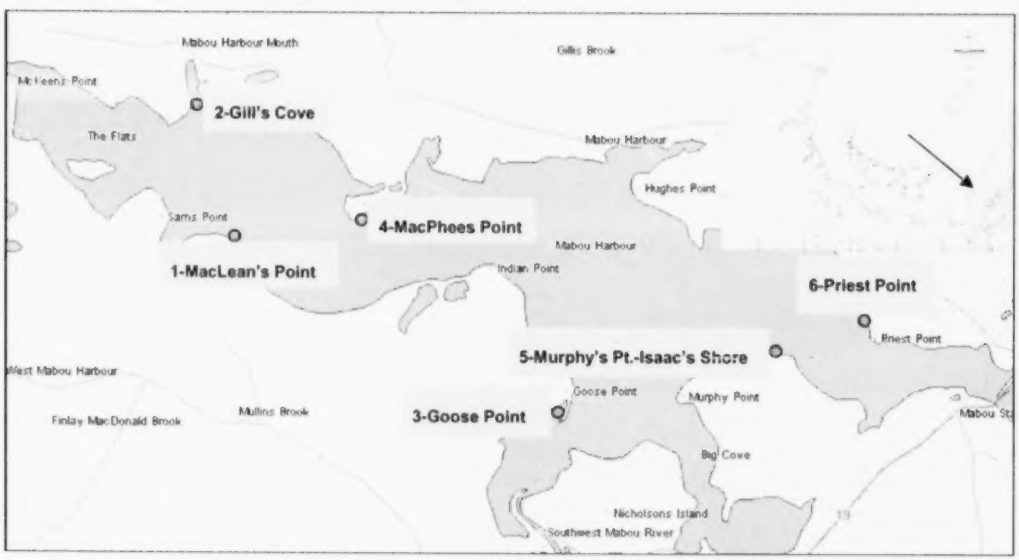
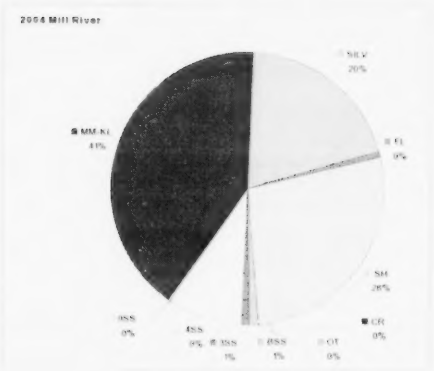
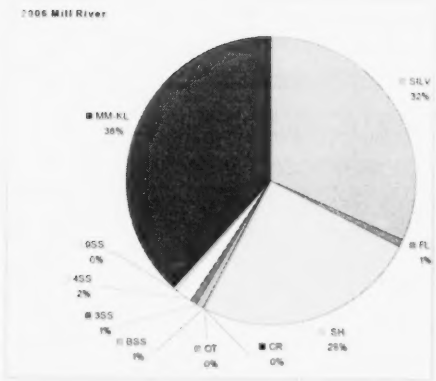
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Nova Scotia / Mabou

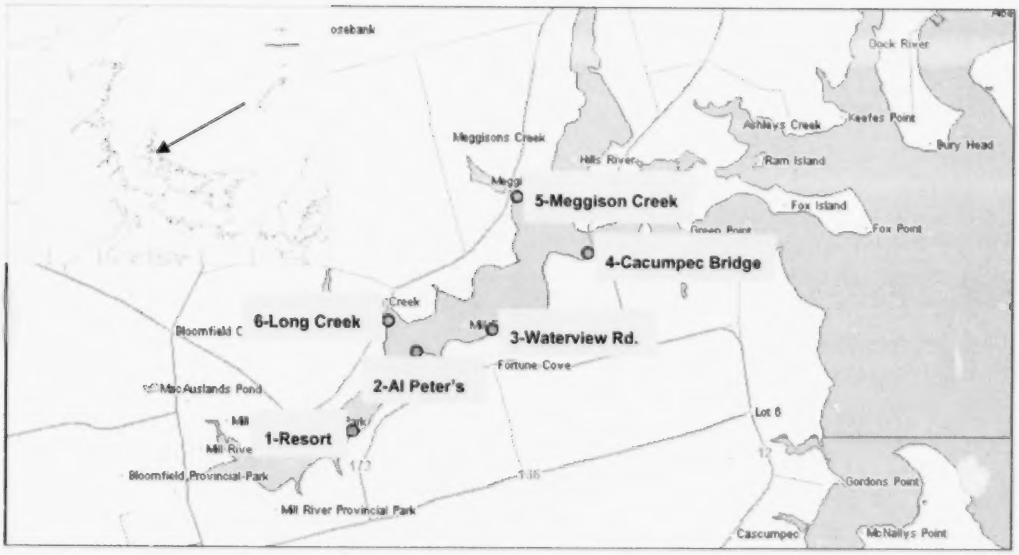


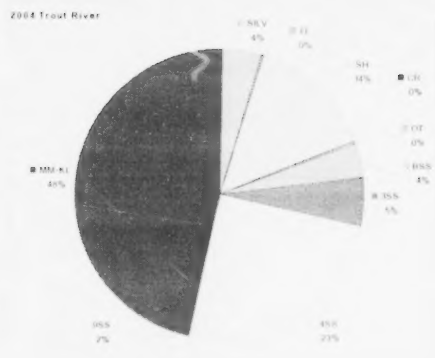


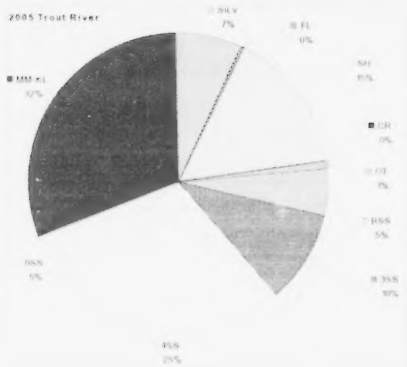


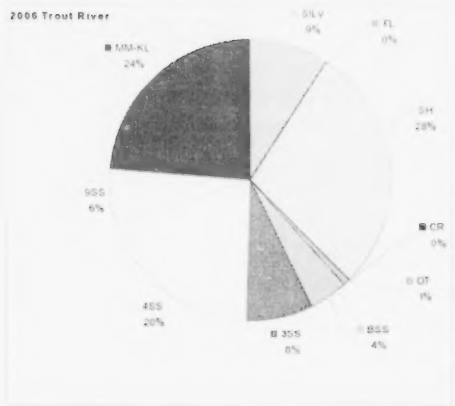
Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
3 Spine Stickleback (3SS)	Flounder Species (FL)
4 Spine Stickleback (4SS)	Shrimp Species (SH)
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Prince Edward Island / Mill River









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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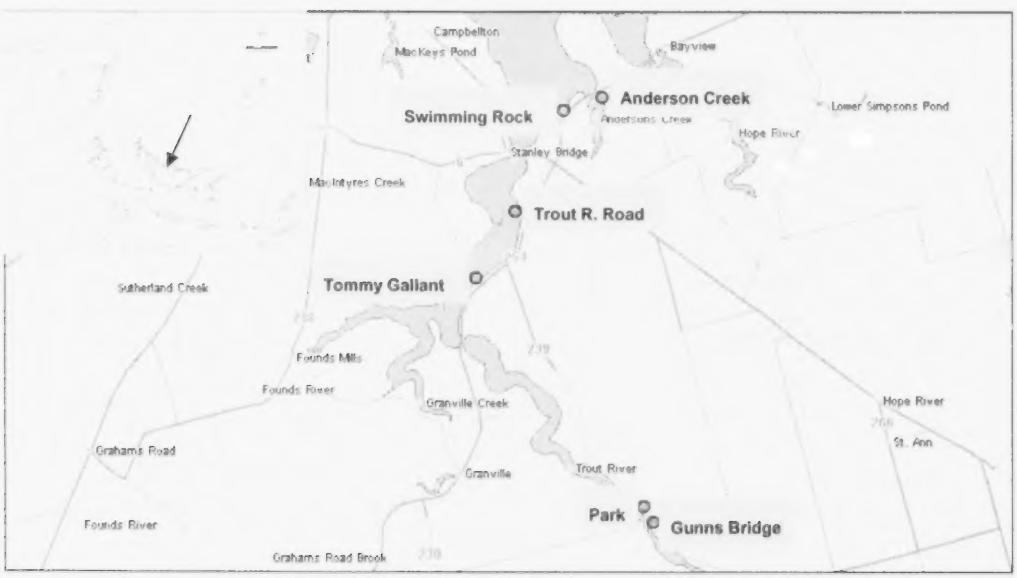
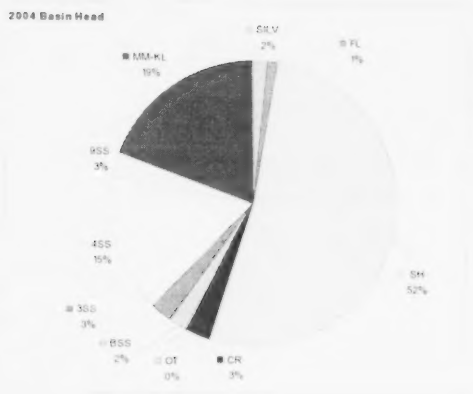
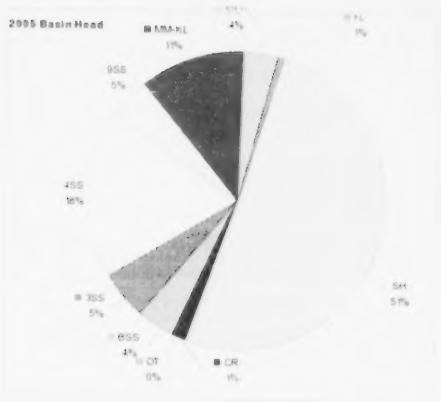
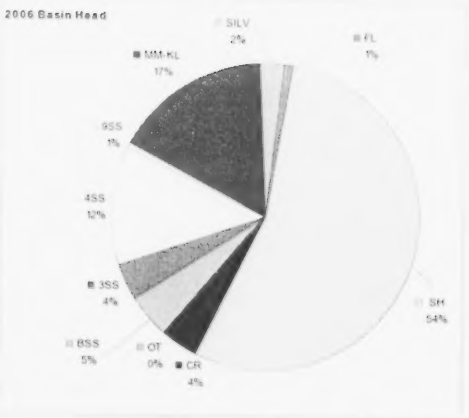
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Prince Edward Island / Trout River









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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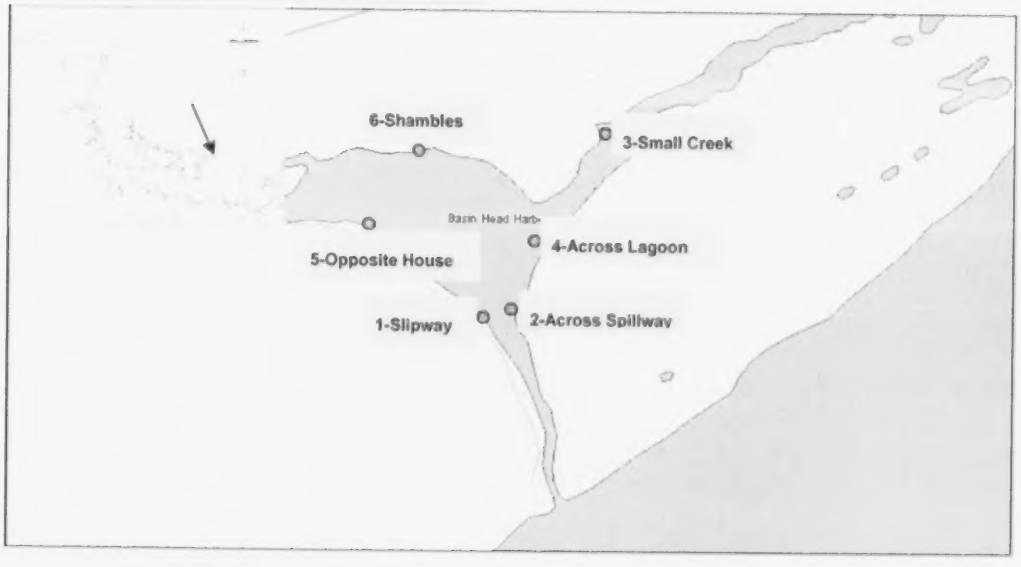
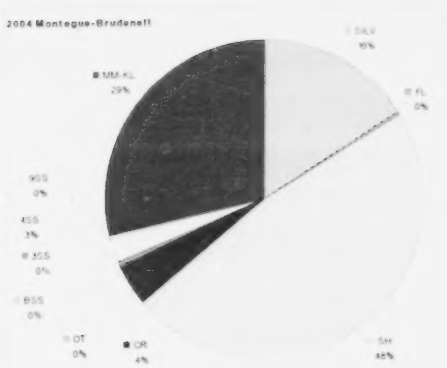
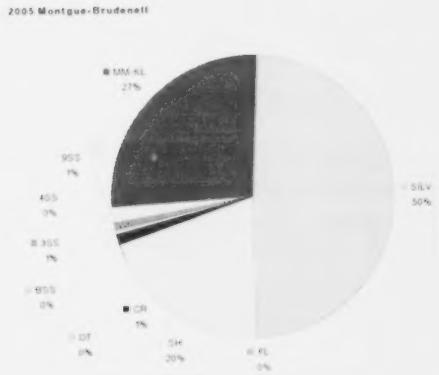
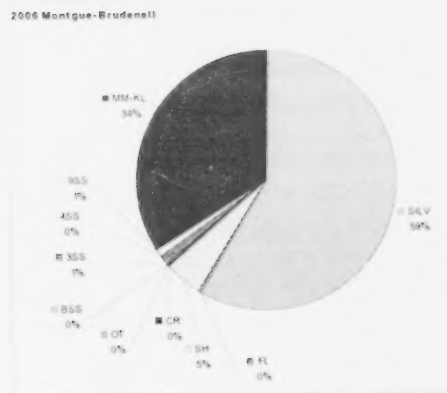
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Prince Edward Island / Basin Head









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
3 Spine Stickleback (3SS)	Flounder Species (FL)
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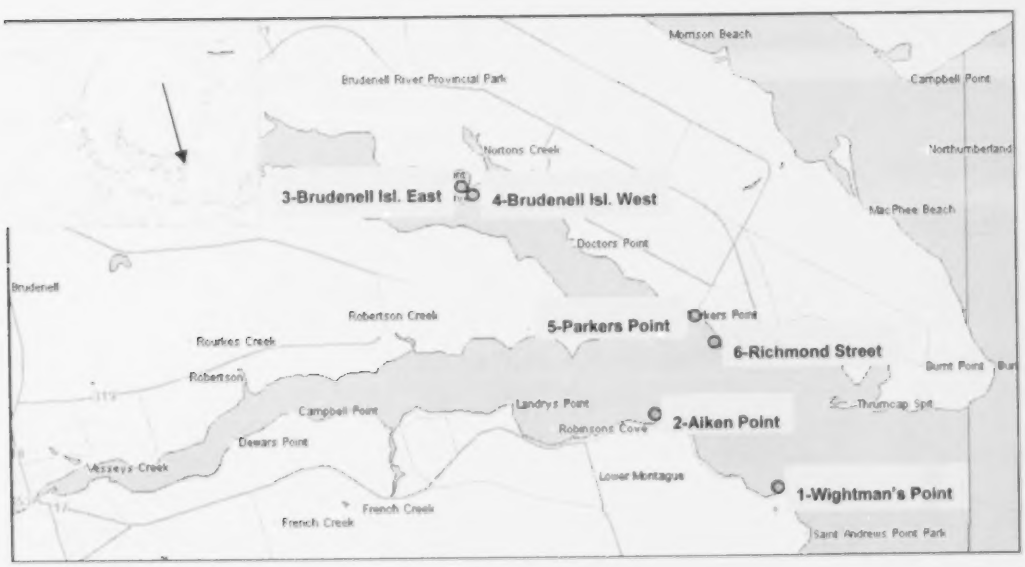
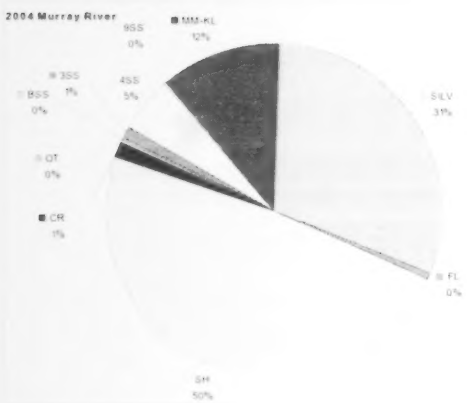
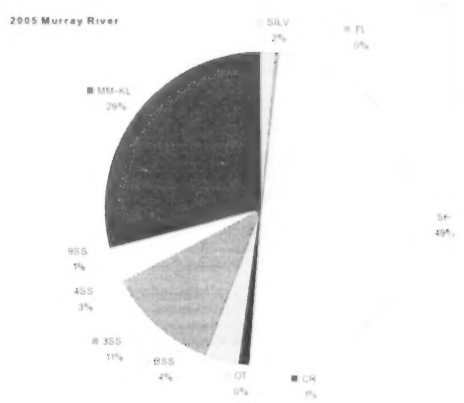
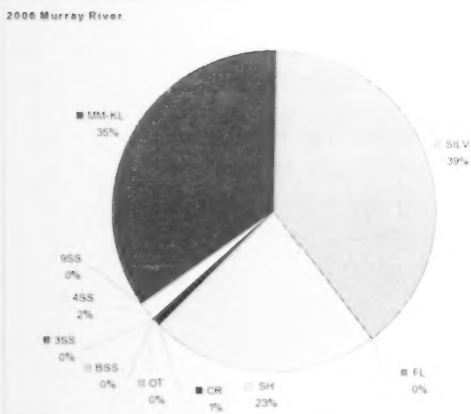
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Prince Edward Island / Montague-Brudenell









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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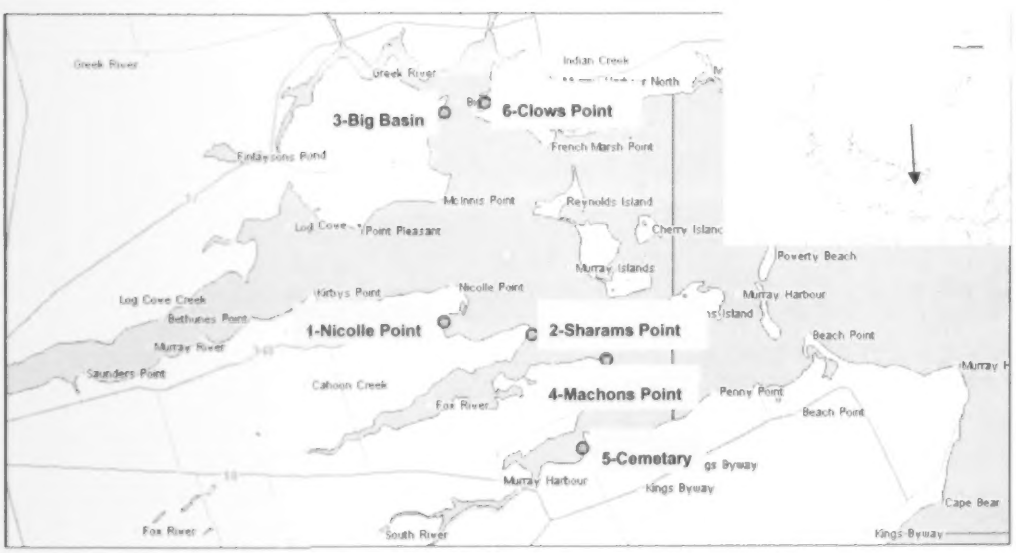
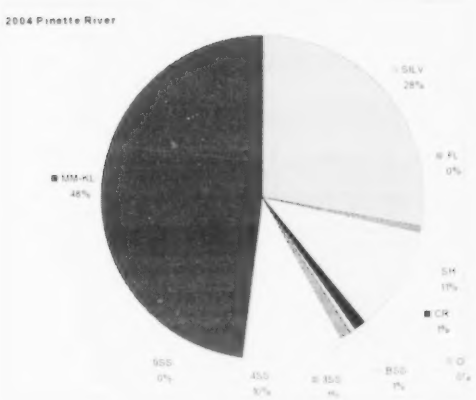
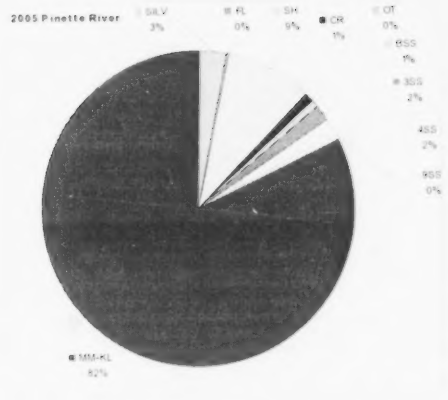
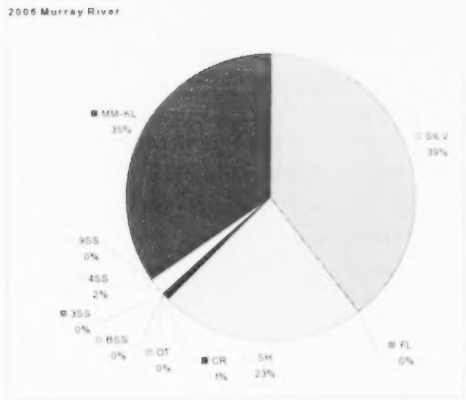
9 Spine Stickleback (9SS)	Crab Species (CR)
Mummichog/Killifish (MM-KL)	Other Species (OT)

Prince Edward Island / Murray River









Black Spot Stickleback (BSS)	Atlantic Silverside (SILV)
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Mummichog/Killifish (MM-KL)	Other Species (OT)

Prince Edward Island / Pinette River